January 31, 1911.

FEB 1 1911

POWER

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Index to Advertisers Follows Reading Matter

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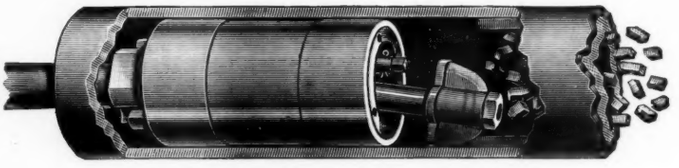

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Let us send you one on trial.

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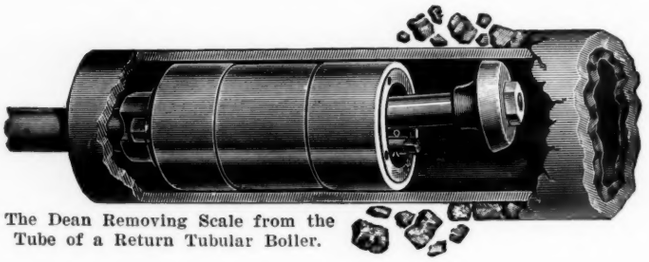

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POWER

NEW YORK, JANUARY 31, 1911

THERE is a right and a wrong way of doing most everything. In fact, there often are several wrong ways of doing a given thing.

Usually, the discovery and use of the *one* right way only come after considerable study, experience and practice.

What a masterpiece of skill is necessary to dock successfully a great ocean liner of perhaps twenty-thousand tons displacement. Yet, the feat is accomplished every day in the year without anyone making a particular "noise" about it. The reason that the operation is successful so often is that the men intrusted with the task know the right way in which to do it as the result of years of training.

In the power plant there are a thousand and one operations, both simple and difficult, for the performance of each of which there is one *right* way.

Bring a barbarian into a plant and set him to work tightening up a one-half inch cap screw, for instance. If the screw happened to be a bit rusted and he could not turn it easily with his fingers it is only natural to expect that he would take the biggest wrench in the place to it, rather than put a "bit" of oil on the threads, start it right and use a suitable sized wrench to turn it home.

The barbarian is accustomed to accomplishing things by brute strength rather than by the use of intelligence.

The equipment under the care of some engineers lasts for a remarkably large number of years and gives efficient service during all of the time. On the other hand, the same kind and grade of equipment under men of another type has but a brief and riotous career full of wastefulness.

The reason for this is that the engineers of the former class use intelligence and care in operating the machine, not abuse and neglect. They see to it that each machine is amply lubricated and kept at least decently clean. Further, they make repairs promptly and thoroughly, realizing that "a stitch in time saves nine" and that "a thing worth doing is worth doing well."

And it pays—in the longevity of the apparatus and the uniformly good service which it gives.

Make the means selected for doing a given piece of work *fit* the purpose. Use efficient methods—efficient from every point of view, if possible.

In other words, use intelligent, civilized methods, not barbaric ones.

A 120,000 Horsepower Plant in France

By A. Grandjean

The St. Denis station supplies light and power to the city of Paris under several different phase and voltage conditions, as well as furnishing direct current for the railways. To meet these requirements several novel arrangements are made in the electrical equipment. The coal handling apparatus also embodies some notable features.

One of the largest and most important power plants in France is the St. Denis station of the Electrical Society of Paris. This is situated on the banks of the Seine between the towns of St. Ouen and St. Denis, and, in addition to supplying light and power to the greater part of Paris, also delivers about 20,000 horsepower to the Metropolitan railway of that city. At present the total output is 100,000 horsepower, but after the additions, which are now in the course of construction, have been completed, the station will have a capacity of 120,000 horsepower.

From Figs. 1 and 4 it will be seen that the general layout of the plant is somewhat different from that ordinarily met with. Owing to the large area available it is spread out considerably, the building covering approximately 160,000 square feet, and by having the coal bunkers in separate buildings, the hight of the boiler house is made much less than is the usual practice.

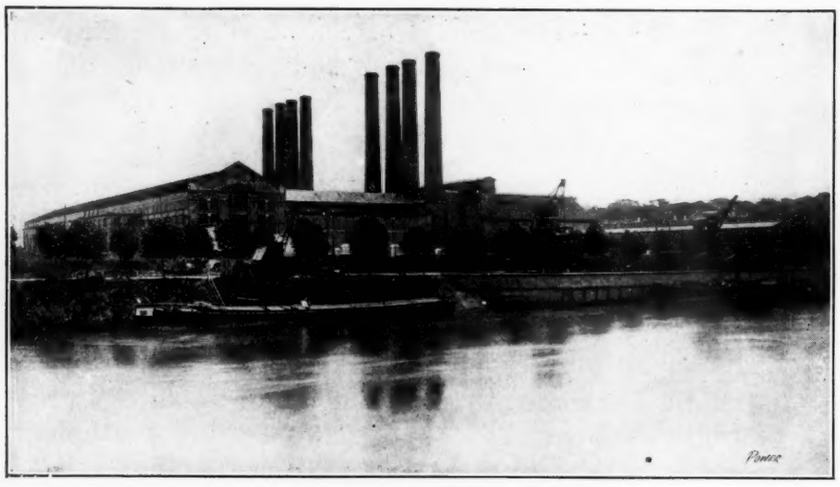


FIG. 1. EXTERIOR VIEW OF PLANT

COAL-HANDLING APPARATUS

One of the most interesting features of the installation is the means for handling coal. This is brought by scows direct from the collieries to a concrete wharf, in front of the power house. Two electrically operated traveling cranes, see Fig. 3, with clam-shell buckets pick the coal from the scows and deliver it into automatic weighing hoppers, one attached to each crane. And from each hopper it is discharged onto a conveyer, running parallel to and over the crane track. At the end of this conveyer the coal passes through a transfer hopper and is elevated to a second conveyer, running at right angles to the first and passing between the boiler houses and the coal bins of each group. This second conveyer consists of a roller chain carrying pivoted steel buckets,

FIG. 3. METHOD OF UNLOADING BARGES

which are hung so as to always remain in an upright position, regardless of the direction in which the chain is traveling. Each bucket is provided with a cam by means of which it may be tipped at any point in its travel. Passing over and under the aisles between each two rows of boilers and extending over and under the coal bins is a third conveyer, by which coal may be transferred from the second conveyer to the bin or to the hoppers over the boilers, or can be delivered directly from the bins to the hoppers. This ar-

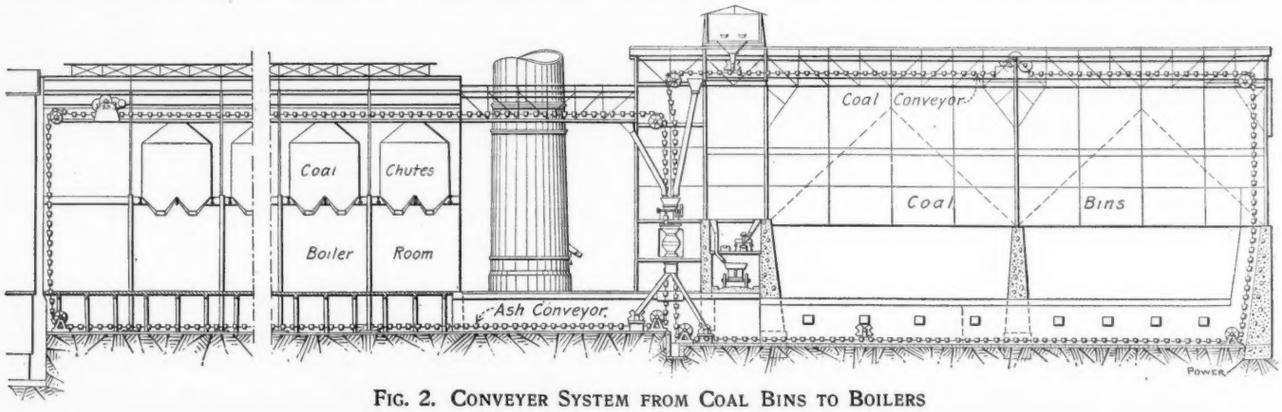


FIG. 2. CONVEYER SYSTEM FROM COAL BINS TO BOILERS

rangement is shown in Fig. 2. Fig. 5 is a view of the conveyer over the boilers. This conveyer in passing under the boilers is also used to carry away the ashes and discharge them into dump cars. The system has a capacity for handling 40 tons of coal per hour and, when unloading, only three men are required to each scow, one man operating the crane and two men to guide the buckets. From the time the coal has been delivered by the buckets, no further handling by hand is required. The total length of conveyer at the plant amounts to nearly 8000 feet.

Boilers

At present there are forty-six 450-horsepower boilers of the Babcock & Wilcox marine type, arranged in batteries as shown in Fig. 4; but when the additions now under way are completed, the number will be increased to 58. Chain-grate stokers are employed, two to each boiler, and, in addition to the draft furnished by the 180-foot chimneys, this is supplemented in four of the batteries by a forced-draft system. The feed water is heated by Green economizers located over the boilers, and Babcock & Wilcox superheaters attached to each boiler are capable of raising the temperature of the steam to 652 degrees Fahrenheit, the superheaters being arranged so that the temperature may be varied through a range of 180 degrees. Fig. 7 shows a sectional elevation through one of the boilers and Fig. 6 a view of one of the boiler rooms.

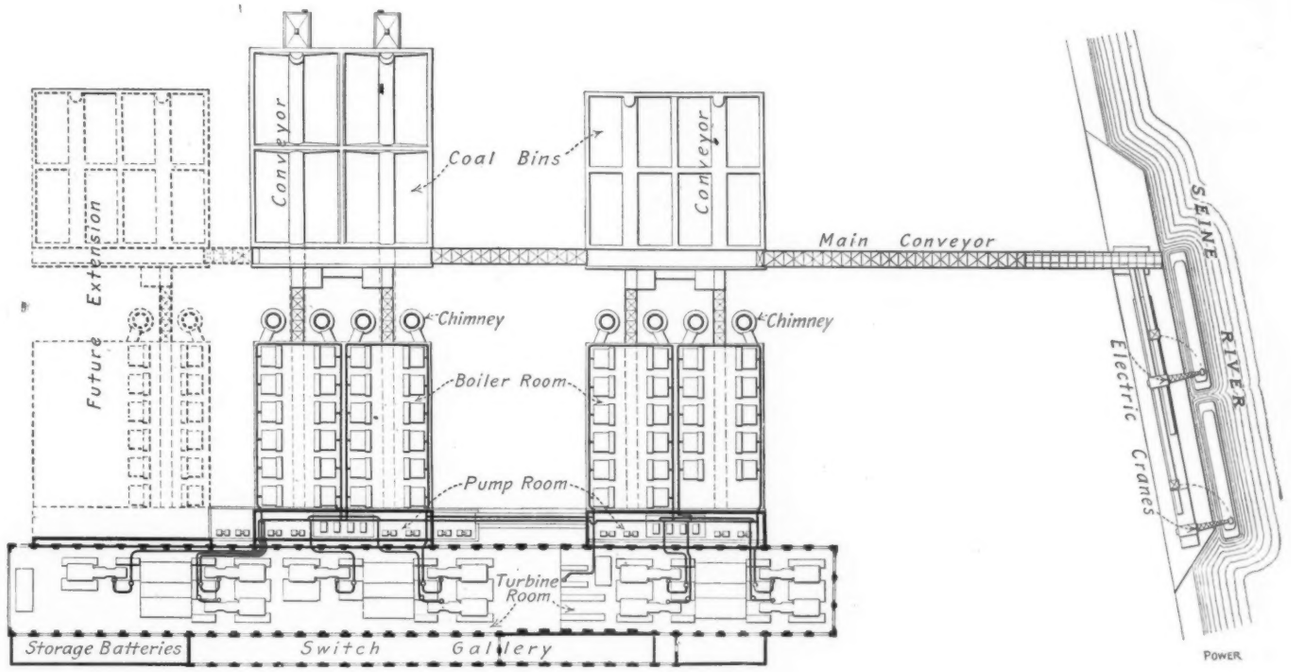


Fig. 4. General Layout of Plant

Piping and Auxiliaries

The turbines are mounted in groups, thus greatly simplifying the piping layout. Steel piping is employed for all high-pressure steam and riveted sheet-iron pipe for the exhaust steam. The condensing water is led from the condensers by submerged pipes working on a siphon, so that the work of the circulating pumps is reduced.

The surface condensers are located below the turbines and the pump room is situated between the boiler room and the turbine room. The circulating pumps are of the vertical centrifugal type, driven by motors, and the air pumps are of the three-cylinder plunger type, also driven by motors.

Fig. 5. Conveyer Over Boilers

Fig. 6. One of the Boiler Rooms

Main Units

Some complication arose from the fact that three-phase alternating currents at about 10,000 volts and 25 cycles were required for traction purposes; two-phase 42-cycle currents at 12,300 volts for lighting; three-phase currents at 6000 volts and 42 cycles for distributions to the suburbs; direct current at 230 volts for plant service, and direct current at 550 volts for certain other traction purposes. To meet these various classes of service the following units were installed:

Four three-phase turbo-generators of 5000 to 6000 kilowatts capacity.

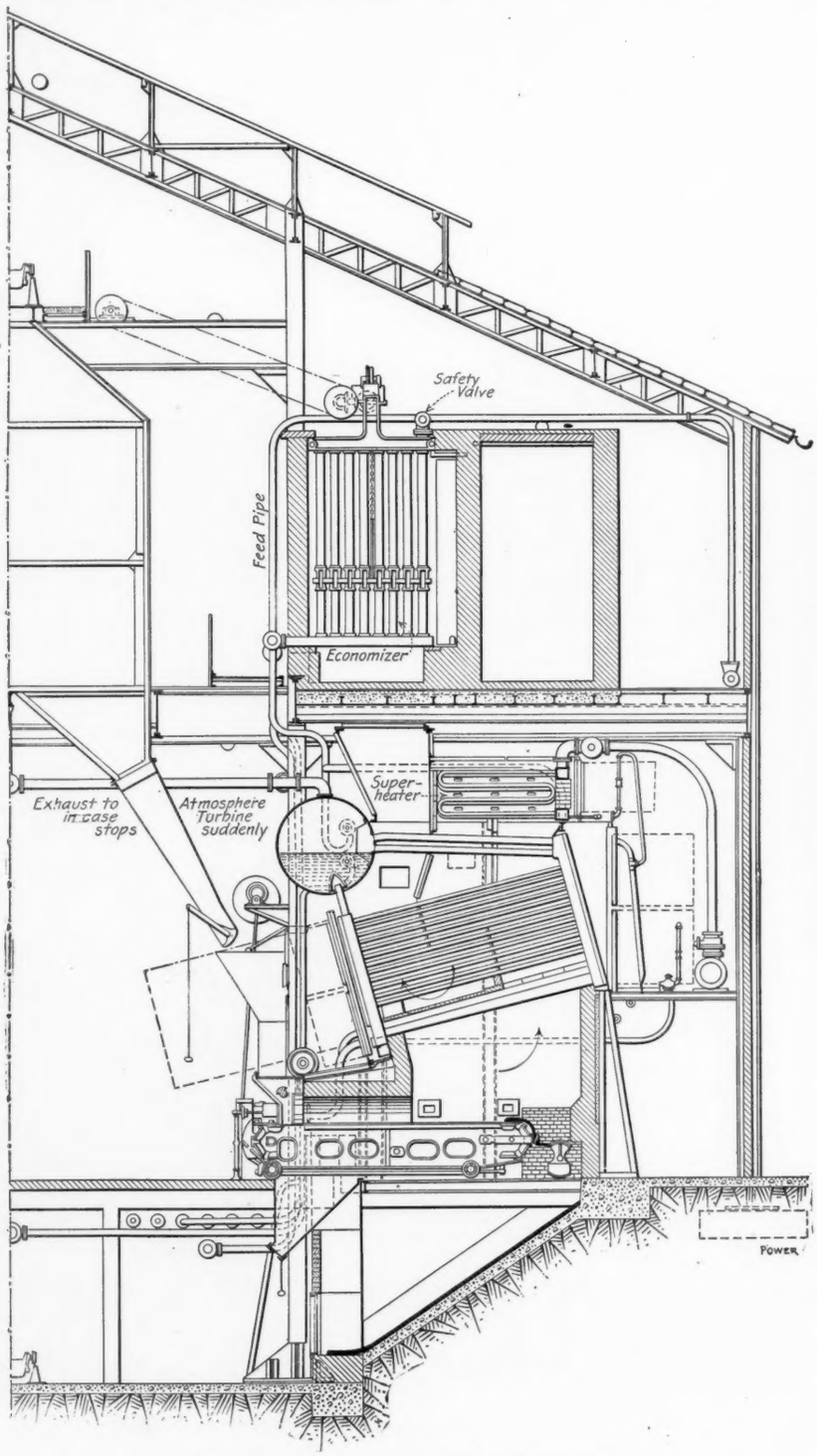


Fig. 7. Section through Half of Boiler Room

Four two-phase turbo-generators of 5000 to 6000 kilowatts capacity.

Two turbines, each connected to two alternators, one of which is a two-phase, 42-cycle, 12,300-volt machine and the other a two-phase, 25-cycle, 10,150-volt machine of 5000 to 6000 kilowatts capacity.

One two-phase, 25-cycle, 10,150-volt turbo-generator of 10,000 to 14,000 kilowatts capacity.

Two two-phase motor-generator sets, each of 750 kilowatts capacity, taking alternating currents at 12,300 volts and delivering direct current at 220 volts.

Two motor-generator sets of 750 kilowatts capacity, taking three-phase current at 10,150 volts and delivering direct current at 220 volts.

Two motor-generator sets of 375 kilowatts capacity, taking three-phase currents at 10,150 volts and delivering direct current at 220 volts.

One 375-kilowatt, 230-volt direct-current turbo-generator.

One storage battery of 1300 ampere-hours capacity and another of 3000 ampere-hours capacity.

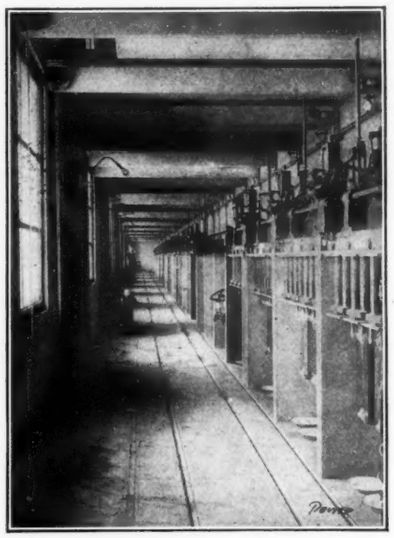


Fig. 8. Switch Compartments

Two motor-generator sets for charging the storage batteries.

Two 6050- to 12,300-volt static transformers, each of 1000 kilowatts capacity.

The speed of the three-phase machines is 750 revolutions per minute and that of the two-phase machines is 835. Each turbine is provided with a Parsons speed regulator which maintains a practically constant speed in spite of the varying load, especially on those machines supplying the electric railways. The admission of steam is automatically cut off as soon as the speed of the turbine reaches 15 per cent. above normal.

In addition to the foregoing there is a special reversible motor-generator set consisting of two synchronous motors coupled together, one being fed with three-phase current at 10,150 volts and 25 cycles and the other with two-phase current at 12,500 volts and 41⅔ cycles. The three-phase motor has six poles and the two-phase motor, ten poles. As

$\frac{25}{41.66} = \frac{6}{10}$ it will be noted that both motors run at the same speed, that of 500 revolutions per minute. Therefore, it is possible, by using either of the machines as a motor or a generator to transfer available power from the three-phase machines to the two-phase circuits or *vice versa*, up to the limit of the capacity of the machine, which is 1500 kilowatts. A view of the main turbine room is shown in Fig. 9, at the right of which may be seen a large lathe used for turning down the commutators.

FIG. 10. GALLERY CONTAINING REMOTE CONTROL BENCHES

SWITCHING EQUIPMENT

The high-tension switching apparatus is housed in a reinforced-concrete structure which adjoins the main turbine room. All the switch barriers and slabs are of concrete and every precaution has been taken to insure against fire. Fig. 8 is a view of the oil switches, showing the track that has been provided for convenience in handling them. In the upper part of this building are located the desks containing the remote-control apparatus; these are shown in Fig. 10. The long desks on the right are for feeder control and the small ones on the left, overlooking the turbine room, are for controlling the machine switches. Each row is separated into two sections, one for two-phase and the other for three-phase currents.

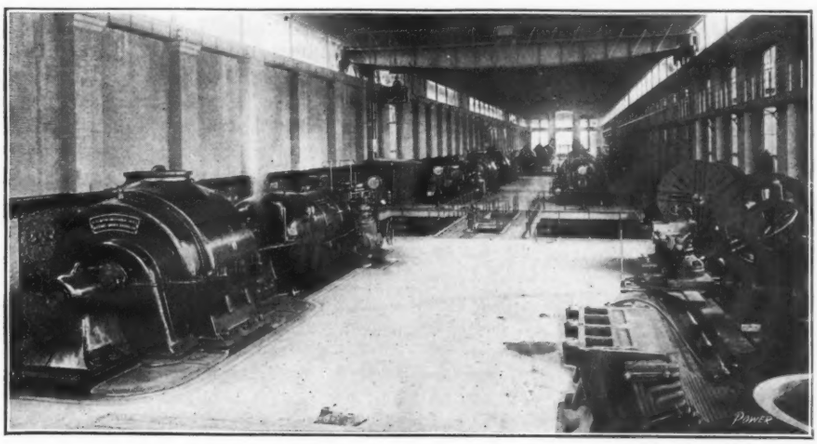


FIG. 9. TURBINE ROOM

On the desks are mounted signal lamps showing the position of the switches and the operation of the rheostats, these lamps being supplemented by a warning bell. With this arrangement the control of the entire high-tension switching equipment is placed under the direction of one operator. The high-tension busbars are divided into groups, the leads from each two generators connecting through oil switches to a pair of generator busbars; each pair of busbars is connected through an oil switch to a pair of feeder busbars which, in turn, connect through other switches to the feeders. These switches have time-limit control, which automatically cuts out a feeder, group or machine in the event of a short-circuit. The several sections of both the generator and the feeder busbars may be connected in parallel, the former by remote-control oil switches and the latter by disconnecting switches. This arrangement permits any section being isolated for the purpose of making repairs.

Along the side of the turbine room and raised slightly above the floor is the low-tension switchboard containing the excitation control and the various instruments. A pedestal located in front of the switchboard and opposite each unit carries a Siemen's apparatus with the wattmeters, voltmeters, ammeters and emergency interrupter for each machine. This board and the pedestals are shown in Fig. 11.

The operating force consists of three shifts of twenty men each, in addition to an engineering and superintendent's staff of eleven.

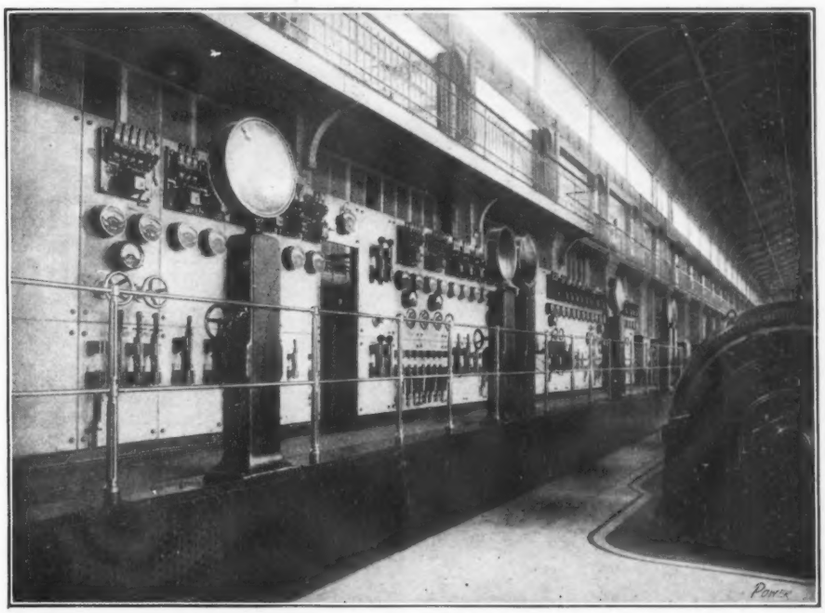


FIG. 11. LOW-TENSION SWITCHBOARD

The Metropolitan Street Railway Company, of Kansas City, will install a 15,000-kilowatt, maximum rating, Curtis turbine and base condenser next summer.

Vacuum for Reciprocating Engines

By John H. Ryan

The experience of a refrigerating man with a young engineer who thought he could better the economy of his engine by increasing the vacuum to 28 inches.

Several years ago the firm by which I was employed built an ice plant in the Southern fruit belt, most of the output being used in refrigerating cars. As coal was expensive in that locality, the plant was designed to operate as economically as possible. The ice machine consisted of two single-acting compressors, driven by an 18 and 36 by 48-inch cross-compound Corliss engine, the flywheel of which was used as a main driving pulley for running, through a jack shaft, the plant auxiliaries. These consisted of a boiler-feed pump, a circulating pump, an electric generator for light and power, the air compressor and a rotary blower for circulating the freezing water.

About two years after the plant had been turned over to the owners we were requested to send a man to the plant to report upon some changes that their engineer had proposed. Upon reaching the plant, I found that there had been a change of engineers, the new man being a young fellow who had been an oiler in a large central station employing turbine units. He had previously taken a correspondence course in refrigeration and then sought a job of greater responsibility, finally landing his present position.

He began his argument for the proposed changes by stating that, although the steam consumption per horsepower-hour of this plant was as good as the turbine plant, the vacuum on the machine did not average more than 24 inches, while the turbine plant averaged 28½ inches. He had looked up the theory of the loss due to incomplete expansion and had found that if the steam in the ice plant could be expanded down to 28½ inches, the consumption would be decreased at least two pounds per horsepower-hour. According to his figures this saving in steam would be equivalent to 18 per cent. of the coal used. The owner of the plant was interested when he saw these figures and signified his willingness to take a chance, providing the machine builders would say that it was feasible. The engineer was not sure as to the cheapest way of increasing the vacuum but had thought of getting a larger air pump, a larger circulating pump and a cooling tower so that the barometric condenser could be forced to its limit. There were a number of other suggestions, such as moving the condenser nearer the low-pressure cylinder, etc. After he had said all he could think of, I started in to have my say, which was somewhat as follows:

"There are many who do not understand why a high vacuum is not as good for reciprocating engines as it is for turbines, but most of us have read or been told that with the former it does not pay to run the vacuum any higher than 26 inches, with the barometer at 30 inches.

"The expansion and compression of gases follow the same laws whether the range of pressures be high or low. For example, consider the compression in an ammonia cylinder when carrying 15 pounds back pressure and it is desired to find what the pressure in the cylinder will be at half of the compression stroke. Add the atmospheric pressure to the gage pressure and multiply the 30 by two, because the volume is halved at half stroke. This gives 60 pounds as the absolute pressure in the cylinder at half stroke. When the 15 pounds atmospheric pressure is subtracted from the 60, it will give 45 as the gage pressure at half stroke, that is, when the volume is halved.

"The same law holds true for the expansion of gases. In a compound engine with 15 pounds receiver pressure and cutting off at half stroke in the low-pressure cylinder, when this 30 pounds absolute steam pressure has expanded down to a full cylinder volume, the pressure will be halved. This is because the volume has been doubled and there will be just atmospheric pressure in the cylinder when the exhaust valve opens at the end of the stroke.

"A pound of steam at atmospheric pressure occupies about 26 cubic feet of space and that is about the capacity of the 36x48-inch low-pressure cylinder. This same pound of steam at 15 inches of vacuum occupies 53 cubic feet of space. To hold this steam the low-pressure cylinder would have to be 4 feet in diameter. At 26 inches of vacuum the volume of a pound of steam is approximately 175 cubic feet and the required cylinder diameter would be 7½ feet, and at 28 inches of vacuum the volume would be 340 cubic feet, necessitating a cylinder diameter of 10½ feet. Or, further, a 29-inch vacuum would require a 14½-foot cylinder. To attain the benefit of the extra inch of vacuum between 28 and 29 inches, the area of the cylinder must be doubled."

The engineer replied that he would be satisfied with the 28 inches; but I told him that his low-pressure cylinder was about right for 21 inches of vacuum and to expand to 28 inches would necessitate a low-pressure cylinder of 60 inches in diameter. To compensate for the attending cylinder condensation, the steam would have to be superheated 500 degrees above that corresponding to the throttle pressure. This would mean a temperature of 865 degrees Fahrenheit and it would be hard to find oil and packing to withstand this.

He accused me of not knowing what I was talking about and said that the engines of the new cotton mill in town often ran 28 inches of vacuum. I admitted that anyone could get 28 or more inches of vacuum if he had water enough and offered to wager that if they took diagrams from the mill engine when it was carrying 28 inches of vacuum that the diagrams would show the exhaust valves opening early in the stroke with the pressure in the cylinder corresponding to 28 inches of vacuum when the piston reached the end of the stroke. There would probably be more than 6 pounds absolute pressure in the low-pressure cylinder when the exhaust valve opened and all this heat would be rejected into the condenser.

He admitted that I might be right, but could not see what difference that made as the 28 inches of vacuum in the exhaust pipe would represent a removal of most of the atmospheric pressure, and he claimed that a pound of pressure removed from the front of a piston was just as good as an extra pound behind the piston. I replied that there was a big difference between the actual and theoretical mean effective pressure when an engine is run condensing. As a rule there is 5 pounds less mean effective pressure with 28 inches of vacuum than calculations would indicate.

His next question was, "What did I think of lowering the exhaust pressure by means of a larger air pump?" This is another way of wasting power. To lower the vacuum from 26 to 28 inches would require a condenser temperature 23 degrees lower and the pump would have to take out about 60 cubic feet more vapor for every pound of steam the engine used.

Our friend then got out his notebook and made these few entries: "Turbines show a gain, due to complete expansion to a high vacuum because the temperatures remain the same at each point in the turbine. They have no condensation loss. Reciprocating engines running with complete expansion to a high vacuum do not show as good results, because the loss from the cylinder condensation is high. Look up the question of B.t.u. per horsepower and see how much of the available heat in the steam I am getting. Charge the heat required to run the auxiliaries, to gain by condensing."

An Efficient Boiler Installation

By H. R. Mason

The description of a recent boiler and economizer installation embodying some novel features. The results of economic tests are given, showing that, by the adoption of these improvements, a rating 28 per cent. in excess of the guarantee was attained under actual running conditions.

An efficient steam-generating equipment is the first essential to a satisfactory power plant, and this feature depends as much upon the design and arrangement of the boiler-room apparatus as upon the skill of the attendants after the plant is completed. The present article deals with the arrangement of boilers, economizers and stacks of a certain large plant which was recently completed.

The original plant consisted of three Heine boilers of 420 horsepower each, in connection with a single economizer, the boilers arranged so that each could be connected directly to one of three 500-kilowatt units. The load increased rapidly and plans were adopted for an extension of the plant by the addition of 2000-kilowatt Parsons turbines, each served by four 480-horsepower Heine boilers with individual economizers, constituting distinct units which could be operated independently from the boiler-feed pump to the condenser discharge.

The boilers were of the standard Heine type and special attention was given to the baffling, exhaustive tests being made to determine the most advantageous arrangement of baffles. It was found that in boilers of this size with only the customary top and bottom baffles, the gases followed nearly a diagonal path from the edge of the lower baffle to the edge of the top baffle, leaving a very large portion of the heating surface ineffective and resulting in excessive stack temperatures at heavy loads. This, of course, brought about a serious reduction in both efficiency and capacity, and was overcome by putting in an intermediate baffle in the following manner: The lower baffle was extended from the front tube header to a point approximately 4 feet 10 inches from the rear tube header, securing an area of about 25 square feet for the gases to leave the combustion chamber and enter the tubes. Under favorable conditions it was found that the combustion-chamber temperature approached 2000 to 2200 degrees Fahrenheit, and that there was an exceedingly rapid transfer of heat to the first tubes which the gases came in contact with. As the gases, in cooling, contract in volume in proportion to their absolute temperatures, the necessary areas and surfaces for the most effective results were easily calculated and an intermediate baffle of cast-iron plates was inserted on top of the ninth row of tubes, extending from the rear header to a point 3 feet from the front header, as shown in Fig. 1. This left an area of 16 square feet at this point for the passage of the gases, and this area was preserved from that point to the top of the stack, as it was feared that the draft would suffer through friction losses if the area were reduced sufficiently to maintain the same velocity. The top baffle was then extended from the front header to a point 3 feet from the rear header, thus reversing the ordinary arrangement. The spaces between the two drums and between the drums and the side walls was such that the breeching was carried back about 6 feet and the remaining areas of the boiler drums, having no strong circulation of gases about them probably did but little work. This amounted to less than 200 square feet, and being in the coolest portion of the path of the gases, it was considered best to sacrifice this small percentage of the heating surface in order to gain the 30 or more per cent. which was lost through the usual form of baffle.

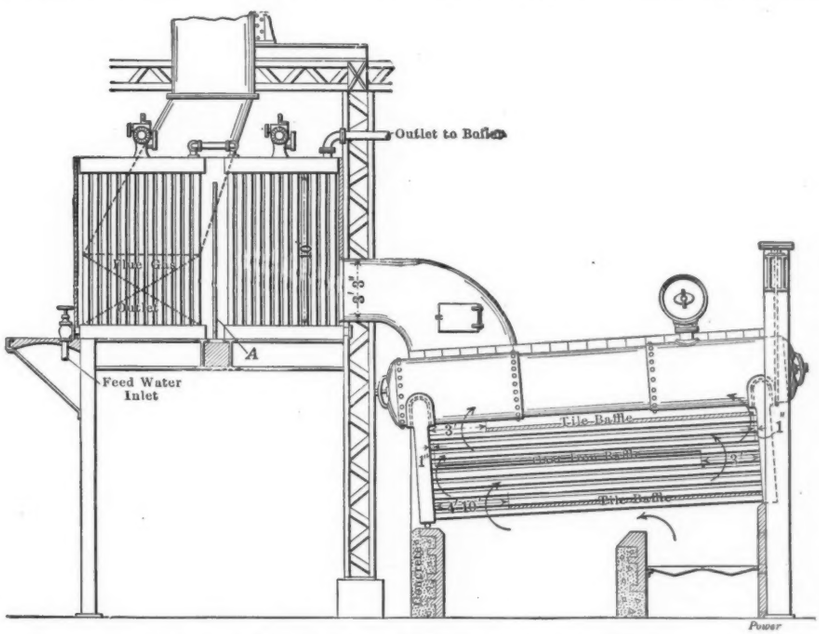


FIG. 1. SECTION THROUGH BOILER AND ECONOMIZER

The columns supporting the front portion of the boilers extend about 22 feet above the boiler-room floor, and carry 24-inch box girders, from which the boilers are hung by yokes passing under the front end of each drum, as shown in Fig. 2. This was done to get the boiler supports away from the heat of the furnace, and also to accommodate any type of mechanical stoker which might be decided upon. The rear ends of the boilers rest upon rollers. The walls are of reinforced concrete lined with firebrick, instead of brick throughout, as is the usual custom. The rear wall is built solid, but the side walls are in sections about six feet square, separated by barriers of 3/8-inch sheet asbestos, as it was anticipated that undesirable cracks would form in a solid wall of such size when exposed to the varying temperatures. In two years these walls have shown very little tendency to crack, and having a hard finish, much less air passes through them than through the ordinary form of brick wall.

In the design of the breeching, economizer baffles and the uptake to the stack, special care was observed to avoid, as far as possible, all abrupt turns which would be liable to cause eddies or back drafts. The gases from each boiler are discharged into an economizer of the standard Green type, provided with mechanically operated scrapers. These economizers are supported by cast-iron columns and jacketed with a series of double sheet-iron plates, 1½ inches apart, with asbestos tamped between, as shown in Fig. 3. The gases enter near the bottom of the discharge section of the economizer and are prevented from going straight through to the stack by a cast-iron baffle plate, shown at *A*, Fig. 1. The boiler-feed water is delivered to the section nearest the stack and passes from the first group of sixteen sections to the

second group, through return bends at the top of the economizer, and is finally discharged from the section nearest to the boiler, where the gases have the maximum temperature.

The steel stacks are 78 inches in diameter and extend 150 feet above the economizer; for the first 75 feet the metal is ¼ inch thick and 3/16 inch for the remaining distance.

Before the erection of the first set of boilers it was argued that the draft might prove insufficient, as the path of the gases seemed unduly long and tortuous, and much of it was in a horizontal plane. In practice, however, it was found that there was little more to be desired. The draft gage and pyrometer showed readings averaging substantially as follows:

	Temperature Flue Gases, Degrees Fahrenheit.	Draft, Inches.
Base of stack	300	1.25
Breeching between boiler and economizer	485	0.75
End of intermediate baffle	770	0.50
Combustion chamber (estimated)	1600	0.37
Furnace (estimated)	2100	0.25

averages showed an evaporation of approximately 6 pounds of water per pound of screenings burned, or an efficiency of nearly 60 per cent. As 70 per cent. is considered very fair on test performances, this result was quite exceptional. The feed water entering the economizer averaged about 150 degrees Fahrenheit and the economizer delivered it to the boilers at temperatures varying from 240 to 300 degrees.

Following is the report of a test on one of these boilers:

RESULTS OF BOILER TEST.

BREESE, TRENTON COAL, FRESH SCREENINGS, 1-INCH SIZE.

Grate surface, 71.75 square feet.
Water heating surface, 4,820 square feet.

TOTAL QUANTITIES.

Duration of test, hours	9
Weight of coal as fired, pounds	21,988
Percentage of moisture in coal	6.58
Total weight of dry coal burned, pounds	20,541
Total weight of ash and refuse, pounds	3,546
Pecentage of ash and refuse to coal as fired	16.16
Percentage of combustible in ash.	Not determined.
Total weight of water fed to boiler, pounds	161,360
Quality of steam, per cent	98.8878
Water actually evaporated, pounds	159,569.7
Factor of evaporation:	
Boiler	1.071
Boiler and economizer	1.1928
Equivalent water evaporated from and at 212 degrees Fahrenheit, pounds:	
Boiler	173,930
Boiler and economizer	192,470

HOURLY QUANTITIES.

Coal consumed per hour as fired, pounds	2,443.1
Dry coal consumed per hour, pounds	2,282.4
Coal per hour per square foot grate surface, pounds	34.1
Dry coal per hour per square foot grate surface, pounds	31.8
Apparent water evaporated per hour, pounds	17,928.9
Water per hour corrected for quality of steam, pounds	17,729.0
Equivalent evaporation dry steam per hour from and at 212 degrees, pounds:	
Boiler	19,110.0
Boiler and economizer	21,147.2
Equivalent evaporation per hour per square foot heating surface, pounds:	
Boiler	3.961
Boiler and economizer	4.38

AVERAGE PRESSURES, TEMPERATURES, ETC.

Steam pressure, gage	160
Temperature of feed water, degrees Fahrenheit:	
Boiler	194
Boiler and economizer	74.2
Temperature of escaping gases:	
Boiler	480
Boiler and economizer	326
Draft over fire, inches of water	0.189
Draft in breeching, inches of water.	0.484
Moisture in steam, per cent	1.1122
CO_2 in flue gas, average per cent	11.35
Calorific value of coal in B.t.u.	10,168.0

HORSEPOWER.

	Boiler.	Boiler and Economizer.
Horsepower developed	560.2	619.8
Builder's rated horsepower (boiler only)	482.0	
Per cent. of rated horsepower developed	116.2	128.5

ECONOMIC RESULTS.

Apparent evaporation per pound of coal as fired		7.34
Equivalent evaporation per pound coa as fired	7.82	8.65
Equivalent evaporation per pound dry coal	8.41	9.22
Efficiency of boiler, per cent	74.2	
Efficiency of boiler and economizer, per cent		80.9

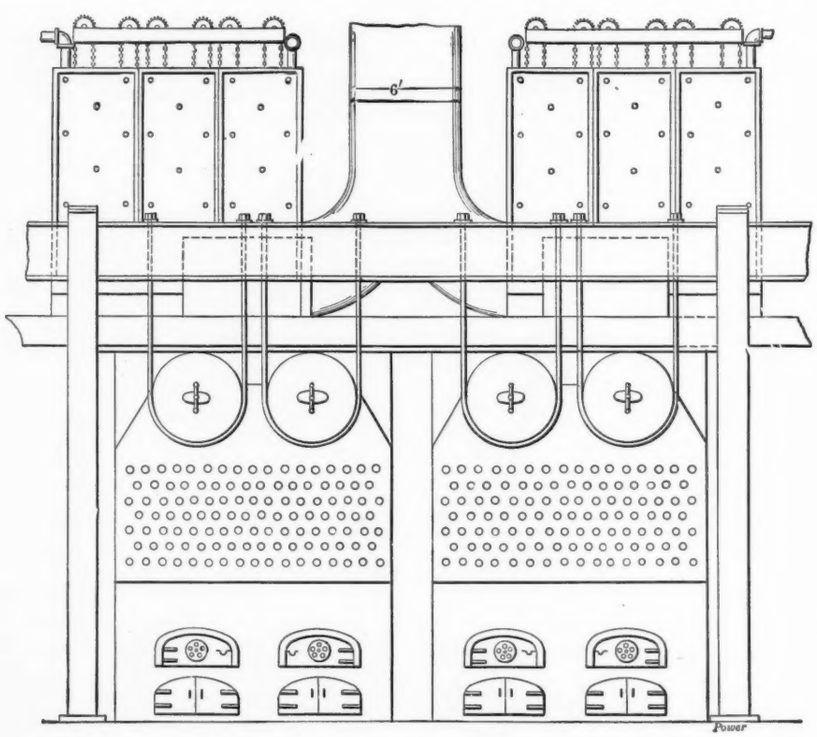


FIG. 2. FRONT VIEW OF BOILERS

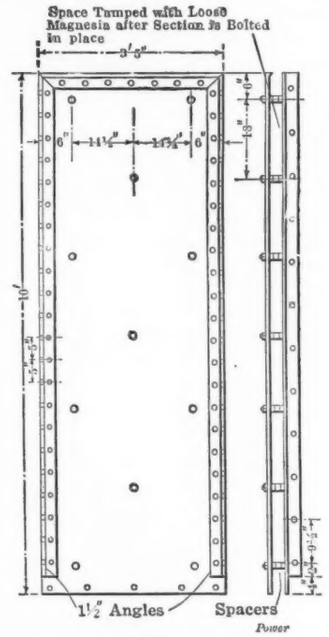


FIG. 3. ECONOMIZER JACKETS

This draft proved sufficient to consume over 30 pounds of screenings per square foot of grate surface, and as the grate of each boiler is 10x7 feet, this produced ample heat with the low grade of bituminous coal to run the boilers far above their rating. The coal had a heating value of about 10,000 B.t.u., and monthly tests cold water was used, with the result that the economizer tubes sweated and gathered a coating of soot, which detracted somewhat from the efficiency of the economizer. Tests with a much better grade of coal gave results as high as 950 horsepower per boiler unit for occasional periods, with nearly the same efficiency. The test shown above was taken under conditions which were sub-

stantially the same as those under which the boilers were normally operated, and the object was to determine the most satisfactory operating conditions.

The first cost of the plant averaged very close to $10,000 per complete boiler unit, including one boiler, setting, supports, economizer and one-half the cost of one stack and its supports. The addition of the intermediate baffle increased the capacity of the boiler to a great extent, and the further addition of the economizer brought the working capacity of the unit up to nearly 650 horsepower. This brings the total cost per boiler horsepower to something over $15, which cannot be termed excessive in view of the high efficiency secured, as a very small percentage of saving in the annual coal bill of a moderately large plant will justify a large outlay of capital in improved methods of construction, provided the plant is subsequently managed in such manner as to realize this saving.

Expansions in Compound Engine

By F. R. Low

In reply to an inquiry the author tells what is meant by the number of expansions in a compound engine and in a simple way shows how the ratio is calculated.

A volume of steam is taken into the high-pressure cylinder. This volume equals the capacity of the high-pressure cylinder up to the point of cutoff and including clearance. It is eventually expanded to the full volume of the low-pressure cylinder, including its clearance. The final volume divided by the initial volume equals the "ratio of expansion," or the number of times the steam is expanded.

It is not necessary to work with actual volumes. Suppose in the accompanying diagram the stroke or displacement of the high-pressure cylinder represents 1; then the clearance volume will be directly represented by the clearance expressed in hundredths of the displacement, the volume displaced up to cutoff by the fraction of the stroke completed at that point, and the total volume up to cutoff by the sum of the two. If, for instance, the engine cuts off at quarter stroke and the clearance is 5 per cent., the volume inclosed behind the high-pressure piston will be

$$0.25 + 0.05 = 0.3$$

of the displacement of the high-pressure piston, or since that displacement is taken as unity, will be represented simply by 0.3.

The areas of the cylinders are to each other as the squares of their diameters. Suppose the low-pressure cylinder has a diameter twice that of the high; its area will be four times as great and with the same stroke (which is usually the case) its displacement will be four times as great, and the same percentage of clearance would give four times as much volume, so that, supposing the clearance of the low-pressure cylinder to be 5 per cent. also, the final volume would be

$$4 + (4 \times 0.05) = 4.2.$$

Then the number of expansions or the "ratio of expansion" would be

$$4.2 \div 0.3 = 14.$$

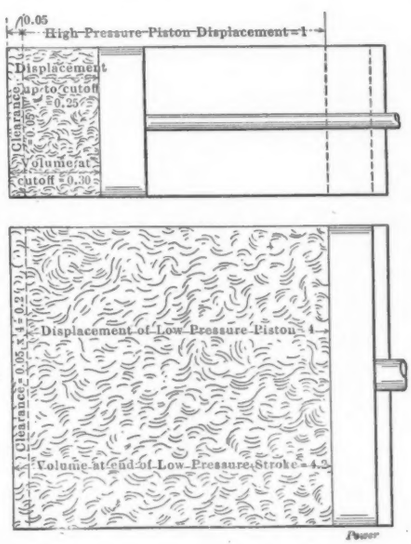
This can be boiled down to the simple rule:

Divide 1 *plus the clearance of the low-pressure cylinder by the fraction of the stroke completed at cutoff plus the clearance of the high-pressure cylinder, and multiply the quotient by the ratio of the cylinders, i.e., by the square of the quotient of the diameter of the low divided by the diameter of the high.*

$$R = \left(\frac{D}{d}\right)^2 \times \frac{1 + C}{f + c}$$

where

R = Ratio of expansion;
d = Diameter of the high-pressure cylinder;
D = Diameter of low-pressure cylinder;
c = Clearance of the high-pressure cylinder;
C = Clearance of the low-pressure cylinder;
f = Fraction of stroke completed at cutoff.



DIAGRAMS OF HIGH- AND LOW-PRESSURE CYLINDERS

Substituting the figures of the previous example where each clearance was 0.05, $\frac{D}{d} = 2$ and $f = 0.25$,

$$R = (2)^2 \times \frac{1 + 0.05}{0.25 + 0.05} = 14$$

To be accurate, all of the steam included in the initial volume does not appear in the final volume, for a part of it is retained in the high-pressure cylinder when the exhaust valve closes. The real case is that a certain quantity of steam is expanded in the high-pressure cylinder and then a portion of this steam expanded in the low. Where extreme accuracy is desired or where a high degree of compression is used it is well to consider the cylinders separately, deducting from initial volume in the low-pressure exhaust, which will depend upon the receiver pressure as well as the point of closure of the exhaust valve. When there is no free expansion or cylinder drop, i.e., when the high-pressure diameter ends in a point, there is no escape of steam into the receiver except as the piston pushes it out. The proportion of the steam passed on to the low-pressure cylinder in this case would be the proportion of the stroke completed at exhaust closure. If, for instance, the exhaust valve closes when the stroke is four-fifths completed, then the volume displaced will be four-fifths of the displacement of the high-pressure piston, and since the entire displacement is taken as unity, will be correctly represented by four-fifths or 0.8. Since the volume of the low-pressure cylinder is proportional to $\left(\frac{D}{d}\right)^2 \times (1 + C)$, the number of expansions in the low-pressure cylinder is, calling the portion of the return high-pressure stroke completed at exhaust closure g,

$$\frac{\left(\frac{D}{d}\right)^2 \times (1 + C)}{g}$$

The number of expansions in the high-pressure cylinder is

$$\frac{1 + c}{f + c}$$

and the total number of expansions is the product of the two, or

$$\frac{(1 + c) \times \left(\frac{D}{d}\right)^2 \times (1 + C)}{g\,(f + c)}$$

Substituting the figures of the above assumed case, and calling $g = 0.8$, this would give

$$\frac{1.05 \times 2^2 \times 1.05}{0.8 \times (0.25 + 0.05)} = 18.4$$

a considerable difference, for a very ordinary ratio of compression.

Confessions of an Engineer

By R. O. Warren

The chief gives the firemen their own way and fails to realize how much coal is being wasted. The manager makes some suggestions which result in a large saving.

Over a week passed before Manager Wood again came into the engine room, although I had seen him several times out in the boiler room, not that he interfered with the firemen, but he seemed to be noting how the men did their work.

If I had had enough sense, I would have known that Wood was getting interested in the combustion conditions of the plant, but for eight months I had seen that the firemen kept up steam and that seemed, to me, to signify that my fireroom force was well organized.

I had read about and discussed boiler-room conditions, time and time again, and had pointed out the mismanagement of other steam plants, but somehow or other it never seemed necessary for me to look into the working condition of my own.

The local association members had been discussing the combustion of coal for years, and had taken up the subject of CO_2, showing how the economy of a steam plant could be increased if a high CO_2 could be maintained. I had been greatly interested in the subject, but as soon as I found out that an instrument cost up in the hundreds of dollars, I came to the conclusion that the matter was not of enough importance for me to bother with, as the chances were, I assumed, that the firm would turn it down if I should ask them to purchase a CO_2 recorder costing so much money.

Now, I knew that air leaking into a furnace through a boiler setting reduced the furnace efficiency to a considerable extent, and I had, therefore, sealed all cracks. so that the boiler setting was in good shape.

For this reason I did not bother much about Wood looking around, but I did make up my mind that if he interfered with the men there would be an understanding as to who was chief engineer.

Wood, however, was a sensible man, and gave me no opportunity of demonstrating which of us was "boss." If I had known him better, and cut out some of my own self-importance, I would have been better off in many ways.

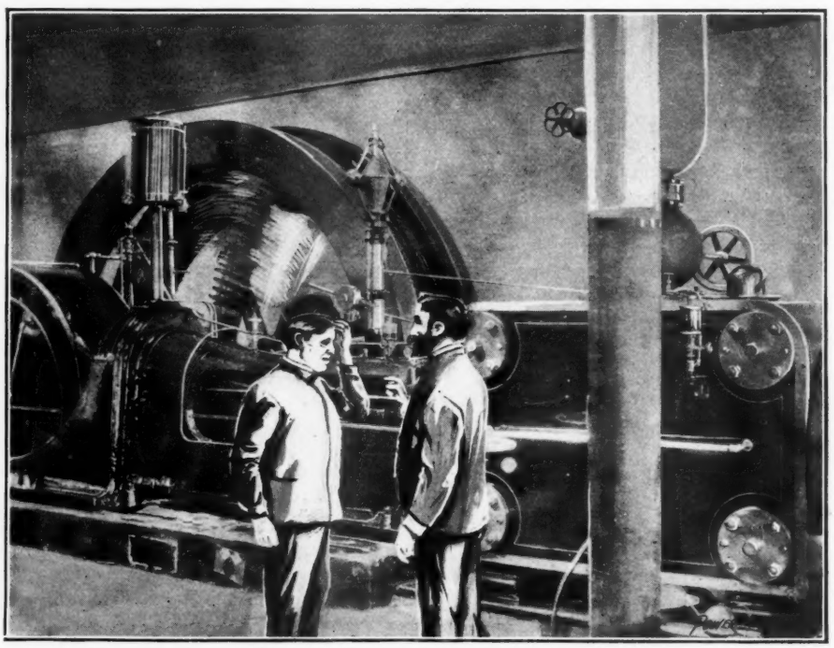
The second visit of Wood was made one forenoon while everything was working to perfection. The firemen had the boiler pressure at the blowing-off point and were sitting down, contented that there was sufficient steam and a little more.

"Good morning, Warren," said he. "How are things going?"

"Fine as a fiddle," I answered, noting with satisfaction that the boiler pressure was up above the normal working point, and that the engine was cutting off shorter than usual.

"Got some pretty good firemen?" was his next question.

"Can't be beat," I answered. "They are the best boys in the town, willing to work and will do just what they are told. The only trouble is that they will take advantage of me if I am not strict. They are like most people for that matter. If you give them an inch, they will take a foot. I don't have much to do with them, because they are apt to get familiar, which won't do." I said this with considerable pride, as I felt that such a stand added to the dignity of my position.



THE MANAGER HAD ME GUESSING

Wood said nothing, but coughed slightly. After a pause he said, "Good firemen are scarce, and men who would make good firemen are not properly trained. The losses a fireman causes in a steam plant are next to the furnace losses, which are the largest. In my opinion a good fireman has greater responsibility, as far as fuel is concerned, than the engineer. The engineer's business is to see that instructions are carried out, and if he fails to do so and the fireman shirks his duties, the plant is in a bad way, from an economical standpoint at least."

I acknowledged that he was right, supposing that Wood was speaking on generalities.

"You said a little while ago that the firemen would take a foot if you gave them an inch. I should judge they had taken something like a yard this morning."

"How so?" said I, and I was never more surprised in my life.

"Well," said Wood, "they have allowed the safety valves on the boilers to blow for over ten minutes since I've been in here, and I have heard them blowing off several times before this morning. They surely have different instructions than that."

"Of course," I replied. But to tell the truth I had never told the firemen anything about blowing safety valves. I assumed that they would look after the matter without instructions from me.

I made up my mind I would give them a "jacking up" as soon as Wood went away. I never did, however, for, after our little séance was over, I came to the conclusion that no one was to blame but myself.

Continuing, Wood said: "The blowing of a safety valve means that coal has been burned in heating water and changing it into steam that will never do any work in the engine cylinder. So far as the company is concerned, the coal might just as well be thrown into the streets. You can see the point, can't you?"

Yes, I could see the point, and I felt like kicking myself when I thought that it was necessary for the new manager

to call my attention to the fact that I was allowing my firemen to waste coal by letting the safety valves blow off for long periods. I tried to justify myself by saying, "The firemen should know better than to get up such a head of steam."

"You can't blame the firemen for getting through the day as easily as they can. If they were getting three or four dollars a day it would be a different proposition. It is up to the chief engineer to see that only such methods are practised as produce economy."

"A man don't like to keep jawing his men all the time," I grumbled, trying to justify my shortcomings.

"It isn't necessary," replied Wood. "A chief engineer should be obliged to issue an order but once and the men should be made to know that when an order is issued, there is but one way out of it, and that is to obey it."

"I guess you would have a good time getting the men in most boiler rooms obeying every order," I answered, for I was becoming nettled by the way Wood was getting at me.

"There would be no trouble at all. The first disobedience of orders might be overlooked, but the man should be warned. The second occurrence would probably end in the discharge of the man unless a good excuse was forthcoming. If an engineer cannot enforce his orders —if he does not know how to handle men, then he is most likely to be a failure. There must be someone about the steam plant who is in charge."

As Wood said this he looked through me, so it seemed, and somehow I felt that he meant me, and that I was getting just what I deserved.

"I don't have that kind of trouble with my men," I protested. "We get along all right."

"No, I've noticed that there is very little friction, but perhaps you do not exert your authority. Most men will get on with their chief so long as they have their own way—so long as he is an 'easy mark.'"

"I'm no easy mark," I remonstrated.

"I hope not," replied Wood, and after a pause said, "The point is just this. You are chief engineer of this plant. I am manager. It is up to me to get economy out of the mill, and it is up to you to get the steam plant running on as economical a basis as possible, but—the firemen won't do it. They won't save coal unless they are shown how, and that is where you come in."

"The men don't throw away coal. I have watched the coal pile for that very thing," I rejoined, and my spirits began to rise.

"There is more than one way of throwing away coal," replied Wood. "I have seen it done more than once since I came here."

"I'd like to know where," I challenged, although I was beginning to see that Wood had me cornered, but just at what point I did not know.

"Well, for instance," replied the manager, "just as I was coming in through the boiler room, one of the men had a fire door open, but before throwing in a charge of fresh fuel, he stopped to fill a pipe, light it and crack a joke with one of the other men. All of this time cold air was being drawn into the furnace over the fire, and coal was thrown away in heating that cold air. There can be no doubt about that, can there?"

"N-o-o," I said, rather faintly, for he had me "going," as the saying is. There was nothing else to say. I knew he was right. I knew that a loss was occasioned every time a furnace door was opened, but here again I had failed to put my knowledge into practical use. I had just the thing that was lacking, but did not use it. Why? Because I did not think that such a small matter made much difference one way or another. I had not taken the trouble to figure out that a little loss here and a little loss somewhere else, added together, made a big item in the total loss account. Here again it was a case of dozing in the engine room while the firemen allowed wastes to occur that I should have prevented. And the worst of it was, the new manager had noticed the loose way in which the boiler room was being managed.

"That was only one instance," I managed to say. "You could probably come into the boiler room a hundred times and never see a man do such a thing again."

I went a little further as my courage returned and was willing to bet that he could stay in the boiler room all day unnoticed and would not see a second like occurrence. But I knew he would, for if a fireman would do any particular thing once, he would do the same again.

"Let it go at that," said Wood. "I noticed another practice that seems to be followed regularly. I refer to the men firing heavy and then allowing the damper regulator to take care of the steam pressure."

"What's wrong with that?" I asked, although I knew well enough. Here was another case of knowing and not seeing that the proper thing was done.

"You wouldn't think of building a furnace of the latest design and then stopping up the tubes of the boiler in order to prevent heat going up the stack, would you?"

"Of course not," I answered.

"Then, why should you build a furnace under a boiler and then allow the firemen to stop up the smoke uptake?"

"I don't allow any such thing. The men don't do it either," I replied, rather nettled.

"It amounts to practically the same thing. You allow the firemen to fire heavy, and in any manner they choose, and then when the pressure rises the damper closes, shutting off the draft in the uptake and deadening the fires in the furnace. The result is that the fires, the furnace and the boiler are not allowed to work efficiently and good coal is thrown away, because the furnace is not worked to its greatest capacity."

"That's splitting hair," I retorted, although I knew he was right.

"Nothing of the sort," replied Wood. "Let's get down to coal dust and see if the thing isn't about as I say it is. Now the rate of combustion in a boiler furnace depends upon the ratio of heating surface to grate surface, the draft and the condition of the furnace and the character of the coal."

"Of course, everybody knows that," I replied.

"Well, now," said he, "what is the lowest rate of fuel consumption per square foot of grate surface that you know of, and what kind of coal would you use?"

"About 8 pounds, I guess, and poor coal and boiler setting," I added, as vague recollections of such figures came before my mental vision.

"And what is the best?"

"Between 35 and 45 pounds," I answered, "but it would have to be good coal and the best of furnace conditions," I added.

"I guess that would be about right," replied Wood. "That would mean about 3.5 pounds to 10 pounds of coal per horsepower per hour. Quite a difference. Now, boilers such as we have here should burn between 12 and 15 pounds of coal per square foot of grate surface per hour. If the amount of coal is less, the furnace is not doing the proper amount of work. If the rate of fuel consumption is increased, the efficiency of the furnace is increased."

There was no getting around that and I admitted that he was correct.

"If that is so, then better conditions can be obtained if a high rate of combustion is maintained, but it can't be done with the damper closed a portion of the time. And if the damper is frequently closed, it shows that more boilers are being used than is necessary."

"I don't believe that condition exists here," I protested, but having had my attention directed to the matter I was aware that the dampers were closed a whole lot more than I had thought.

"I am not so sure about that," was the rejoinder. "My observations of the way the men work and the condition of the fires and working of the damper lead me to think that a boiler could be cut out just as well as not. Of course, I am not running the steam end—only have an interest in it as is natural—but if I were you, I would try getting along with one less boiler."

The tone was not threatening at all, but it had a ring that caused me to act upon the suggestion.

The result was a surprise to me. When the firemen were told to cut out one

boiler, as they were at the end of the day's run, considerable grumbling was indulged in, which showed me that the manager was correct when he said that men could get on with their chief so long as they had their own way.

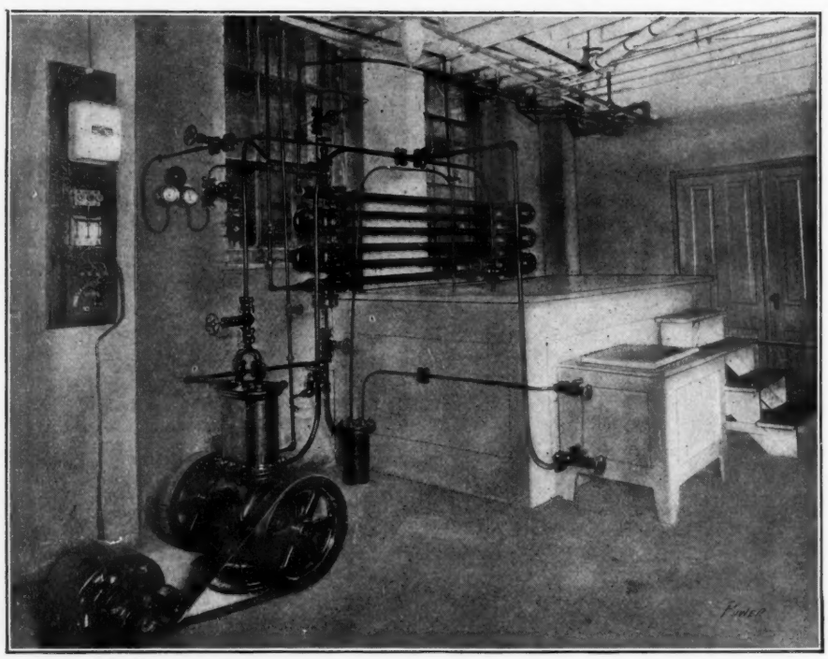
But the boiler was cut out, and the plant was run with one less boiler than it had been for the remainder of my stay. The difference was that the men had to fire oftener, the damper seldom closed and the coal consumption was greatly reduced; just how much, I do not recollect at this late day.

Low Pressure Refrigerating System

By R. C. Turner

The illustration shows an interesting little refrigerating system which is installed at the Commerce Hall building in Atlanta. The machine is of the single-acting type, of 1 ton capacity, and is driven by a 2-horsepower motor. The refrigerant used is Picteau fluid, and only a very small charge (22 pounds) is required for the system.

It will produce a ton of ice upon the cost of 12 kilowatt-hours and 60 minutes labor charge, the machine being in charge of the elevator operator. The cost of power being 36 cents and that of labor 25 cents, shows that a ton of ice is produced for 56 cents, not including any depreciation charges, which at the most would be only a cent or two.



Refrigerating Outfit

The method of operation is as follows: First, the expansion valves are closed tightly, then the motor is started and the freezing coils are pumped down to 2 inches of vacuum; next, the expansion valves are cracked slightly and the system is ready. The best results are obtained with a condenser pressure of 60 pounds, a suction equal to 2 inches of vacuum, and the machine running at about 65 revolutions per minute.

The machine, having an inclosed crank case, requires no attention; one gallon of oil put into the crank case being enough for a six months' run. The best oil for the purpose is a fine grade of transformer oil, on account of its freedom from moisture.

Exhaust Steam in Low Pressure Turbines

By George F. Fenno

There are enough good things that can be said about exhaust-steam turbines, without giving false impressions; and engineers should realize just how much power an exhaust-steam turbine can get out of the exhaust from reciprocating engines. The statement is usually made that, theoretically, there is very nearly as much power to be gained from the expansion of steam from atmospheric pressure to a 28-inch vacuum, referred to a 30-inch barometer, as is possible from steam at 150 pounds gage expanding down to atmosphere. This is very nearly true; but in a recently issued catalog of a turbine builder the statement is made that if a pound of dry saturated steam is expanded from 150 pounds gage to atmospheric pressure, 176 B.t.u. are available for conversion into work, when the expansion is adiabatic; that is, without receiving heat from or imparting heat to any outside body. It is then stated that a pound of dry saturated steam expanding from atmospheric pressure to a 28-inch vacuum renders 169 B.t.u. available for turning into work. A comparison of these figures shows that the expansion of steam in the lower range renders available for useful work only 7 B.t.u. less than that given up by the expansion of steam in the upper range. While these statements are true, the comparison is not fair, for if starting with a pound of dry saturated steam at 150 pounds, this same pound of steam is not saturated after expanding down to atmosphere. Therefore, the statement of the turbine builder assumes that the steam at atmospheric pressure has a much higher heat content than is usually the case. For instance, using the Marks and Davis entropy diagram, it will be found that when the original pound of dry and saturated steam expands from 150 pounds gage to atmospheric pressure it does give up about 176 B.t.u. which a perfect engine could convert into work, but that at the end of this expansion which, it must be remembered, is done at the expense of the internal energy of the steam, the steam has a quality of approximately 85.7 per cent. This is on theoretical grounds alone. In actual practice the quality of the steam will not be as high as this, due to cylinder condensation and radiation. However, to give the turbine the benefit of all doubt, assume that the quality is as high as 85.7 per cent. Now, in order to make a fair comparison, it must be remembered that the exhaust turbine must take the steam at this point and expand it down to the vacuum. Of course, in practice the turbine does not receive wet steam, as separators are inserted in the line; but this does not alter the argument, for this means that for every 100 pounds of dry steam used by the reciprocating engine, the exhaust-steam turbine receives only 85.7 pounds of dry steam at atmospheric pressure.

Starting at this point, with the steam at atmospheric pressure and with a quality of 85.7 per cent., and expanding it down to a 28-inch vacuum, referred to a 30-inch barometer, the heat content will drop from 1018 B.t.u. to about 869.7 B.t.u. That is, in the lower range of expansion there are really only 148.3 B.t.u. available for converting into useful work during adiabatic expansion, instead of 169 B.t.u. as claimed in the pamphlet referred to. So that, whereas this pamphlet claims that 96 per cent. as much energy is available in the lower range of expansion as in the upper; in fact, when correctly figured out, this proportion is only 84.3 per cent.

However, this 84 per cent. is well worth conserving, and turbine builders should be satisfied with it. Nevertheless, manufacturers should be careful about the statements they make in their literature, especially as engineers nowadays freely consult the catalogs of manufacturing concerns, realizing that they often contain the latest information in regard to the advance of engineering science.

The Straight Flow Steam Engine

By Rulof Klein

This engine, designed by Professor Stumpf, discharges its steam through large slots at the center of the cylinder. It compares favorably in economy with compound or triple-expansion engines and is much simpler and cheaper to build. The engine has met with great favor in Germany.

In a paper read before the Berlin District meeting of the Verein Deutscher Ingenieure, Prof. J. Stumpf, of the Charlottenburg Engineering College, Germany, inventor of the straight-flow steam engine, of which the principle of operation has been described in a previous issue of this paper, has described its thermal principles and published the vital details of construction and some operating performances, which should be of great interest to all readers familiar with steam-engine operation.

General Principles

In treating the thermal principles, he compares his one-cylinder creation throughout with the triple- and even the quadruple-expansion engine, because its ratio of steam expansion is about equal to that in these types, running from 1 to 15 to 1 to 30 or even higher, according to the load and initial steam pressure. See Fig. 1.

That these high expansions can be obtained economically in a single cylinder is due to the straight flow of the steam through the cylinder similar to the ex-

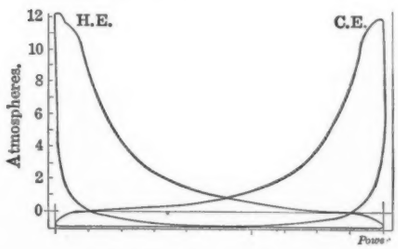


Fig. 1. Sample Diagram

pansion and exhaust flow of the double-acting two-stroke-cycle gas engine of which the elongated piston acts as an exhaust valve, opening slots in the middle of the cylinder shell toward the end of the expansion stroke and closing them at the beginning of the compression stroke. As Fig. 2 shows, the live steam, which preferably is highly superheated, enters the engine through the cylinder head, which it heats and is admitted into the cylinder through the double-seated poppet valve and after expansion is exhausted through the large slots in the middle of the cylinder shell which, as described before, are opened by the piston acting as a huge valve. The advantages of this arrangement above that of the ordinary steam engine can be classified as thermal, constructive and operative.

Thermal Features

The main thermal advantage is the fact that the reëvaporation of the steam during the latter part of the expansion stroke in the ordinary steam engine does not occur here. The loss of heat necessary for this process is prevented in this engine as follows:

The steam entering the cylinder is heated by the compression charge, which is of extremely high temperature. During the expansion, condensation occurs to such an extent that at the end of the stroke the steam contains a great deal of moisture, with the exception, however, of the portion nearest to the steam-heated cylinder head which is kept in superheated condition by radiation from that source. The steam following nearest the piston is in contact with the coolest surfaces and therefore contains the highest percentage of moisture, the more so as here the cylinder wall is of still lower temperature and absorbs some of its heat, to return it later during the compression.

During the period of exhaust the straight-flow engine expels the coldest steam, which contains the largest amount of moisture, retaining the driest portion for compression, in contrast with the ordinary engine in which the hottest exhaust passes out, carrying along the heat of the hot surfaces it strikes when leaving the cylinder.

Compound-, triple- and even quadruple-expansion engines have been built to reduce the disadvantage of great temperature differences of this nature, and equipped with all modern refinements, steam jacketed and superheated, these engines have not been able to establish any record of economy of steam consumption which cannot now be approached by the simple single-cylinder straight-flow steam engine.

A comparison of the combined diagram of the triple-expansion engine, Fig. 3, with the diagram of the straight-flow engine indicated by dotted lines in the same figure brings out the advantage at once.

Although the ratio of expansion is almost the same, the combined diagram is at a disadvantage at points *A* and *B*, the points of exhaust of the high- and intermediate-pressure cylinders. At these points not only a portion of the indicator-card area is lost, but also the corresponding amount of heat on account of the sudden partial expansion. It has been tried to reheat the steam by jacketing but only with its application to the low-pressure cylinder, material advantage has been gained, as the steam entering that cylinder has gradually become so moist and cool that on account of the great temperature differences between itself and the jacket, it is able to absorb heat effectively and regain some lost energy. However, it is all too evident that most of this extra heat is exhausted directly to the condenser. Imagine that during almost the entire revolution of the engine the jacket of the low-pressure cylinder transmits heat to the coolest steam of condenser pressure to have it driven out through the wide-open exhaust valves. In the straight-flow steam engine the extra heat is only absorbed by the steam near the cylinder head, and, as pointed out before, is trapped, as it were, by the returning piston.

Besides the above features, Fig. 3 is

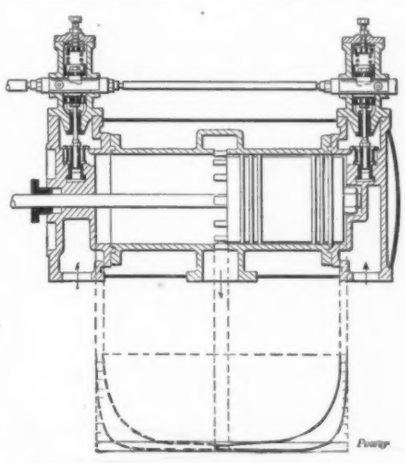


Fig. 2. Cylinder Arrangement of Straight-flow Engine

also a comparison between the indicator diagrams of the two types of engines for the same brake horsepower. On account of its high mechanical efficiency of 92½ per cent., the straight-flow engine does not need as great a cylinder diameter for the same amount of power as the triple-expansion engine in its low-pressure cylinder. The diameters shown here are respectively 33 inches and 34.6 inches. Professor Stumpf claims that under equal conditions his engine can develop the

same power as a compound engine, although its efficient area is only four-fifths of the area of the low-pressure piston of the latter.

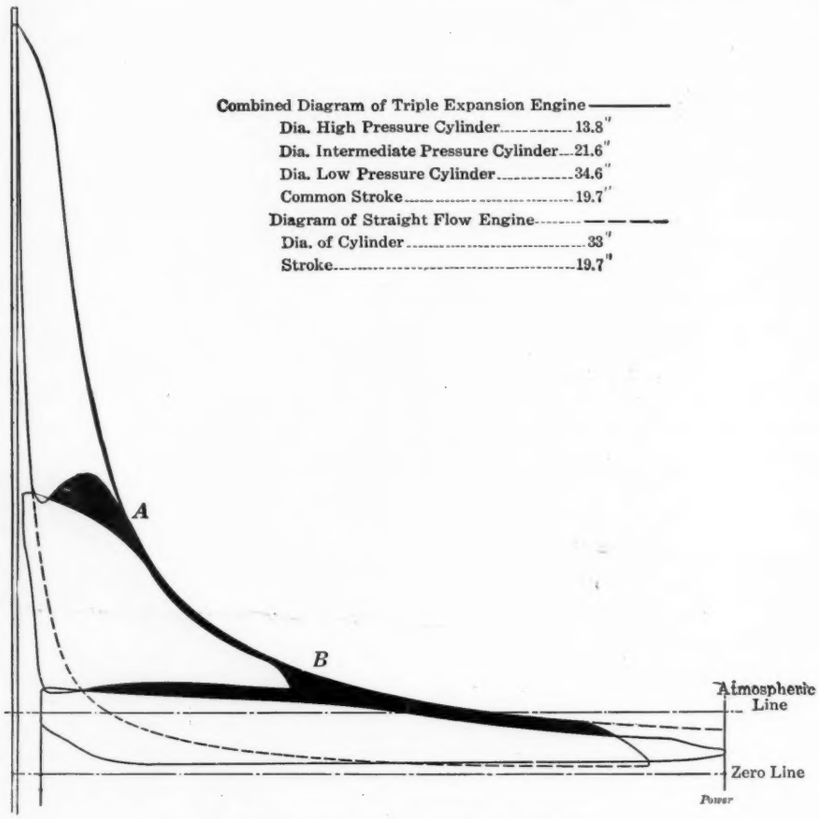


FIG. 3. A COMPARISON OF DIAGRAMS

The compression stroke for the straight-flow engine has also its advantages above that of an ordinary triple-expansion engine as the steam comes in contact with hotter surfaces the more it is compressed, while in the ordinary engine the surfaces of the compression chamber are immediately before swept by the cool exhaust steam. The compression in the new engine, which is carried higher than that in an ordinary engine, equals about the combined compression of the triple-expansion engine with which this engine should be compared. That the temperature of the steam at the end of the compression stroke is well above that of the inlet steam and greatly superheated, is shown by the following figures. Dry saturated steam at 28½ inches vacuum, compressed adiabatically to 177 pounds absolute, or 162 pounds gage pressure, will have a temperature of 1730 degrees Fahrenheit. The temperature of steam at 177 pounds gage pressure and 250 degrees superheat is only 628 degrees Fahrenheit.

High compression from high vacua to steam-inlet pressures seems more or less a necessary evil of this type of engine as the time of closing of the exhaust port is fixed at such a fraction of the stroke as the length of the exhaust slots is to the entire stroke. At lower vacua or atmospheric exhaust, modifications have been made in the described simple construction, in order to prevent the compression from running above the admission line.

To meet these requirements three distinct modifications have been made. For the stationary engine with atmospheric exhaust the clearance has been artificially enlarged by means of an extra compression chamber in each of the cylinder heads outside of the actual steam chest. With a valve in the head, this addition of the clearance can be closed off. For noncondensing operations a clearance of 16 per cent. has been found necessary, quite a good deal larger than the 1½ per cent. of clearance necessary with a vacuum of 28½ inches, or the 3 per cent. of our Corliss engines.

For locomotive engines running likewise noncondensing, the clearance is enlarged artificially to 17½ per cent. by concave construction of the piston ends. See Fig. 4. This design, in principle the same as the previous, has proved very efficient in tests made by the Prussian State Railway. Three locomotives were built especially to compare the merits of the straight-flow, the piston-valve and the Lentz valve engines. The comparison of coal consumption for these different types was respectively in the ratios 1, 1.19 and 1.285, giving the straight-flow engine an advantage of 19 per cent. over the piston-valve engine and of 28½ per cent. above the engine equipped with Lentz valves.

The poor showing of the Lentz valves was partly due to the design of the cylinder, of which both inlet and exhaust valves were located in one long steam port. This feature is in direct opposition to the straight-flow principle, as the steam passage is effectively cooled by the exhaust just before the admission of the live steam.

The latest design of noncondensing straight-flow steam engine, which bears witness of the resourcefulness of the inventor, is shown in Fig. 5. A piston valve is placed inside the piston directly below the rod. It is operated by a little rocker arm, which is attached to the crosshead end of the connecting rod, and rocks about the crosshead pin as center. The valve alternately opens one side of the piston or the other to the respective cylinder ends, procuring passage for the ex-

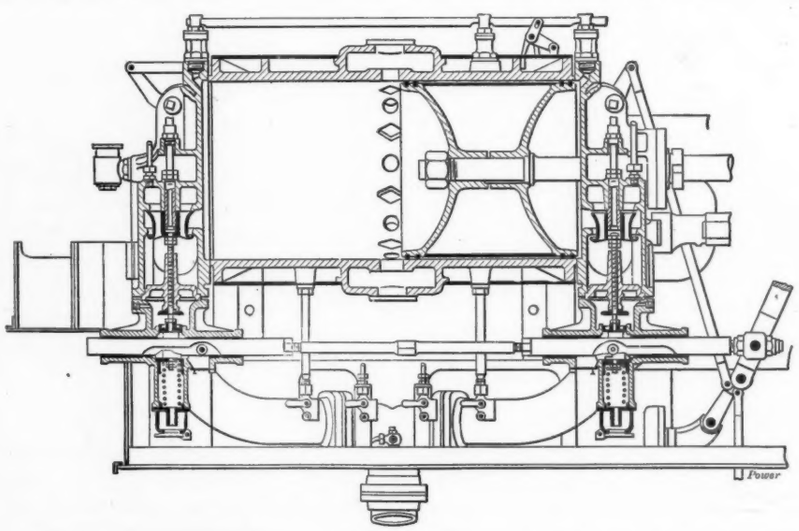


FIG. 4. LOCOMOTIVE CYLINDER, SHOWING PISTON OF CONCAVE CONSTRUCTION

haust steam from these ends through its seat and the holes in the side of the piston to the exhaust slots. These valves close a trifle after the exhaust slots are closed by the second set of piston rings passing them. It is clear that the pressure inside the piston is kept atmospheric throughout the stroke.

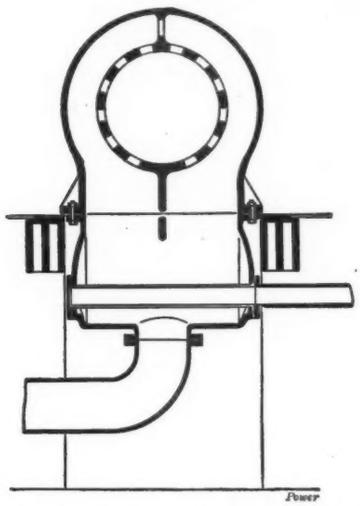


FIG. 5. LATEST DESIGN OF NONCONDENSING STRAIGHT-FLOW ENGINE

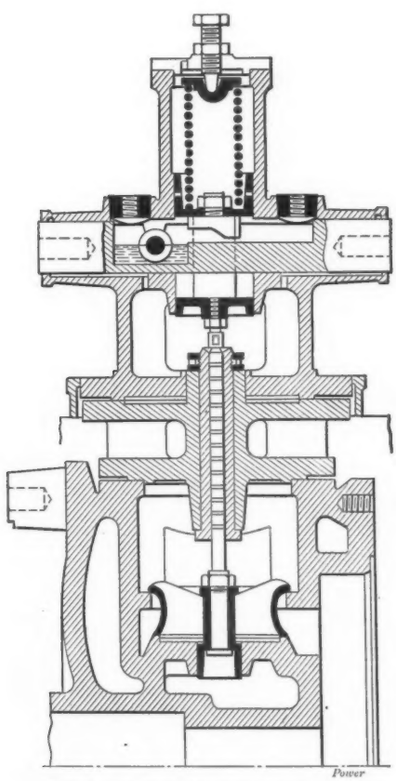


FIG. 6. INLET VALVE AND GEAR

We have seen that during the thermal cycle of ordinary engines, hot steam strikes cooled surfaces and cold steam strikes hot surfaces to the detriment of their efficiency, while this is almost entirely omitted in the new engine and even that portion of the steam which absorbs heat from the cylinder heads during the latter part of the expansion stroke is trapped for use during the compression.

As Professor Stumpf says, in the ordinary engine a thermal washing takes place. Surfaces are heated and cooled constantly, while in his engine both inlet ends are hot and stay hot, while the common exhaust end in the middle of the cylinder is cool and stays cool.

Yet, with all the thermal advantages of his engine, the inventor calls for still higher superheat than is already used in European power houses. He claims that his engine is in better condition to utilize it than any other, on account of its large ratio of expansion. This leaves the steam very moist at the end of the stroke, even if the highest degree of present superheating is applied.

CONSTRUCTIVE FEATURES

As to the constructive advantages of this engine, we detect immediately the absence of exhaust gear and valve; the only visible moving valve part is the rod, shown on top of the cylinder, operating the valves by means of roller and cam similar to the valve gear of the blowing tubs of the Southwark Foundry and Machine Company, of Philadelphia.

As is shown in Fig. 6, the slot containing the rollers is at the same time an oil reservoir which never passes the end of its guide so that oil cannot be spilled nor dust enter. The valve stem is packed by means of a labyrinth packing. The piston, elongated to the length of the stroke minus that of the exhaust port, offers a large bearing surface to the cylinder wall, which is coolest at the point where the piston speed is highest; therefore, favorable friction conditions exist.

On account of the high compression, a great piston speed is possible in spite of the heavy reciprocating parts, preferably 800 to 900 feet per minute. The diagram, Fig. 7, which corresponds to this speed condition shows that the resultant pressure on the crank pin is approximately constant over the entire stroke, most of the high initial steam pressure being absorbed by the inertia of the reciprocating parts to be imparted later to the crank pin, when the steam pressure has decreased. No knock does occur, however, for the compression line passes the inertia line before the end of the stroke, as shown in the lower part of the diagram. As a matter of fact, this engine has attracted attention in operation on account of its smooth running.

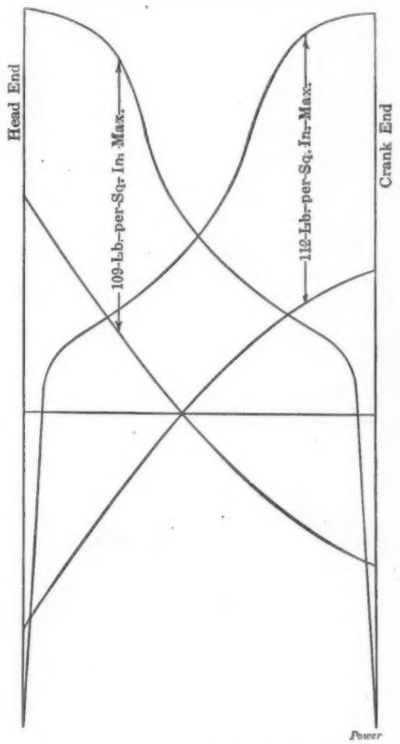


FIG. 7. DIAGRAM OF RESULTANT PISTON PRESSURE FOR ENGINE RUNNING CONDENSING

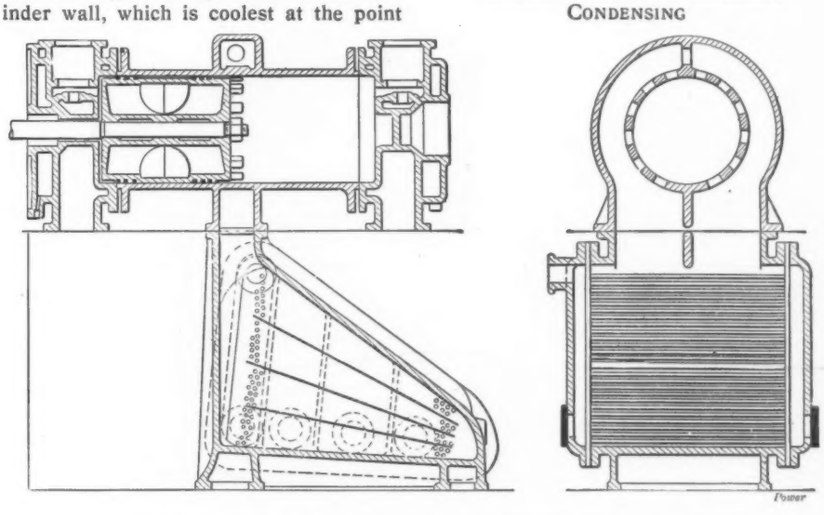


FIG. 8. STRAIGHT-FLOW ENGINE WITH SURFACE CONDENSER

No wonder that with this high speed and heavy reciprocating parts a heavy counterweight opposite the crank pin is

necessary, and also a very solid foundation, for the inertia, which tends to cause vibration, is many times greater with this engine than with an ordinary steam engine of the same power, especially with cross-compound or triple-expansion engines where the different sets of reciprocating parts balance each other more or less.

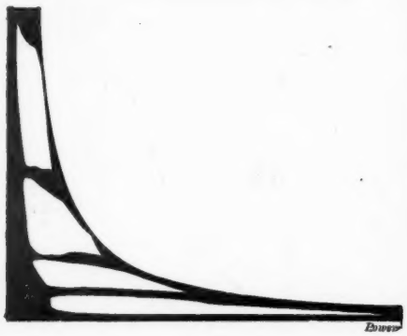


FIG. 9. DIAGRAM FROM QUADRUPLE-EXPANSION ENGINE

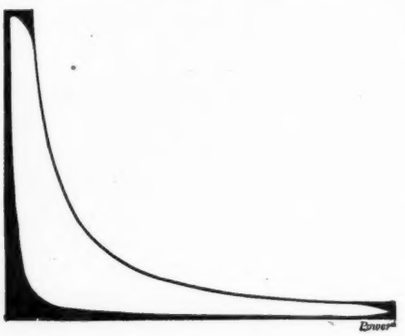


FIG. 10. DIAGRAM FROM STRAIGHT-FLOW ENGINE

On account of the absence of valves below the cylinder of this engine, room is left for immediate connection to the condenser. A surface condenser attached is shown in Fig. 8. The design of the condenser proper is interesting. It offers a large tube area to the inrushing exhaust steam, and is provided with simple trays, which convey the condensate to the outlet, preventing the detrimental flooding of the tubes.

TABLE 1. TEST ON THE STRAIGHT FLOW ENGINE OF THE ELSASSISCHEN MASCHINEN FABRIK.

STEAM ENGINE.	
Average gage pressure at throttle, lb. per sq.in.	179
Average gage pressure at inlet of cylinder, lb. per sq.in.	169
Average steam temperature at throttle, deg. F.	628
Average steam temperature at inlet, deg. F.	581
Vacuum in cylinder, in. of mercury, abs.	4.35
Vacuum at oil separator, in. of mercury, abs.	3.63
Vacuum in condenser, in. of mercury, abs.	2.25
Revolutions per minute	121
Indicated horsepower	503.1
Brake horsepower	465.7
Mechanical efficiency, per cent.	92.5
Steam consumption, lb. per I.H.P.-hr.	10.1
Temperature of cooling water entering condenser, deg. F.	54
Temperature of cooling water and condensate leaving condenser, deg. F.	88
Pounds of cooling water per pound of steam	30
GENERATOR.	
Amperes	1277
Volts	250
Kilowatts generated	319.4
Efficiency, per cent	93
Net kilowatts	307
Steam consumption, lb. per kw.-hr.	16.5

Where an invention has so many advantages as just described, it is hardly possible that not a few drawbacks are attached to it. To the great inertia forces of the reciprocating parts and the large clearance necessary for the noncondensing engines of this type, may be added its enormous maximum piston pressure per horsepower, which necessitates the design of extremely heavy parts.

It is to be compared with the low-pressure part of a triple-expansion engine able to stand the live-steam pressure, necessitating a heavy construction throughout and to develop the energy of all three cylinders combined requiring enormous bearings. To add to this feature the piston and correspondingly the cylinder are abnormally long, which is a feature of all center-exhaust engines.

The cost per unit of power of this engine, calling for a lean diagram for the most economical operation, will therefore be somewhat higher than that of the ordinary single-cylinder engine, although the absence of exhaust-valve gears rectifies this feature to a certain degree. Compared with a compound- or triple-expansion engine, however, with which it so successfully competes in economy, this engine is a good deal cheaper, the reason why it has met with great success in Europe, where its manufacture is taken up by almost all leading engine builders. To date, over half a million horsepower are built or in course of manufacture.

OPERATIVE FEATURES

After the completion of a couple of small experimental engines in 1908, the first 500-horsepower engine was tested in February, 1909. A log of this test is given in Table 1. It shows that with a gage pressure of 179 pounds, 628 degrees steam temperature and a vacuum of 26.4 inches at an oil separator, which unfortunately throttled the connection to the high vacuum in the condenser, the engine consumed 10.1 pounds of steam per indicated horsepower-hour and 16.5 pounds per net kilowatt-hour, including power for the operation of the condenser. That these records have been lowered to 8.5 and 14.4 respectively by a 300-horsepower engine, is shown in Table 2, where the performance of such a small single-cylinder engine is compared with the hitherto most economical triple-expansion engines. In this table are also shown performances of still smaller engines.

Besides the merit of high economy, the straight-flow engine has also a flat efficiency curve, which means that at fractional load or overload it consumes only little more steam per unit of power than at normal load.

The 33 moving parts compared with the 228 on the other engines show its simple construction, which is reason of its low oil consumption and of its being called the "engine with nothing to it."

This feature is especially important with marine engines, where vibrations have to be reduced to a minimum.

Professor Stumpf admits that for smaller capacities, when three or more cylinders are not necessary, his engine stands behind the ordinary type, but claims its superiority with capacities where the application of a great many cylinders is justified, giving for comparison the diagrams of a quadruple-expansion and the new engine, Figs. 9 and 10.

In these diagrams the shaded parts represent losses which are 45 to 40 per cent. in Fig. 9 and only 20 per cent. in Fig. 10. This proves also that the cylinder diameter of the four-unit straight-flow engine can be made smaller than that of the low-pressure cylinder of a quadruple-expansion engine of the same power.

TABLE 2. COMPARISON OF OPERATING PERFORMANCES OF TRIPLE-EXPANSION STEAM ENGINES AND STRAIGHT-FLOW STEAM ENGINES.

Manufacturers.	Indicated Horsepower.	Diameter of Cylinders in Inches. High.	Intermediate.	Low.	Stroke in Inhces.	Rev. per Min.	Number of Moving Parts.	Steam. Pressure.	Temperature.	Steam Consumption per I.H.P. Hour.	Kw. per Hour.
	BEST PERFORMANCE OF STATIONARY TRIPLE EXPANSION ENGINES.										
Sulzer, Switzerland	6000	40	60	2x73	67	83	228	170	572	8.5	13.7
Gorlitz, Germany	6000	40	60	2x73	67	83		170	572	8.5	13.7
Nurnberg, Germany	6000	41	60	2x73	67	83		170	572	8.5	13.7
STRAIGHT FLOW STEAM ENGINES.											
Sulzer, Switzerland	300		23.5		31.5	155	33	130	617	8.5	13.7
Same engine	300		23.5		31.5	155	33	130	0	10.6	
Gebr. Stock, Holland	80		12.6		19.8	200		149	662	9.7	
Burmeister, Denmark			17.8		23.5	180		138	662	9.5	

After being given the speed of a Corliss engine, diameter of shaft, diameter of governor pulley and desired speed of engine, an applicant for a first-class engineer's license said he would raise the steam pressure to increase the speed of the engine.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Catechism of Electricity

THE SELF-STARTING SINGLE-PHASE INDUCTION MOTOR

1134. *Why are single-phase motors built with commutators and brushes as described in the last lesson?*

In order to make them start automatically and with a strong torque when the connections with the supply circuit are closed. An ordinary single-phase induction motor will not start when current is passed through the stator winding.

1135. *Why is the ordinary induction motor unable to start itself?*

Because the magnetic field set up by the winding is stationary and merely induces currents in the rotor conductors exactly as the primary winding of a transformer induces current in the secondary winding. The currents in the rotor conductors do not react on the field in such a way as to cause the rotor to turn, and it must, therefore, be started up by some external means. The commutator motors start automatically, and with a fairly good power factor.

1136. *Is it necessary to use a commutator to make a single-phase motor start automatically?*

No. A single-phase motor can be made to start without using a commutator, and many self-starting motors are built without the commutator arrangement.

1137. *What means is used to make the motor start itself?*

An auxiliary stator winding which produces a magnetic field that is out of phase with the field produced by the main winding. The result is a sort of two-phase rotating field somewhat like that produced in a two-phase motor, but not so uniform or regular in its variations. This rotating field serves well enough to start the rotor, however, if there is no load or a very small load on it while starting. Fig. 371 shows a motor of this kind.

1138. *Describe the construction of this motor.*

The stator is of the same general construction as that of the ordinary single-phase induction motor, but the stator winding is divided into two parts, a main winding and a starting winding, and these are arranged in the slots exactly like the windings of a two-phase motor. The two windings are not alike, however. The main winding is of much larger wire than the starting winding. The rotor is of the simple squirrel-cage type. The construction of the stator and rotor cores is mechanically the same that is used in all induction motors.

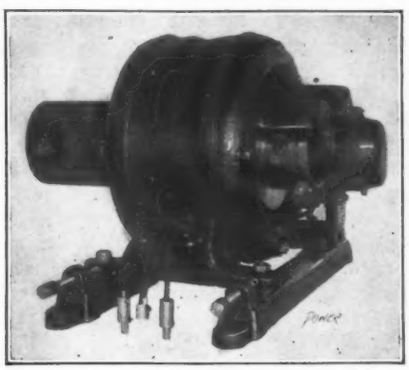


FIG. 371. SELF-STARTING SINGLE-PHASE INDUCTION MOTOR

1139 *Why are the two stator windings made different as to the size of wire?*

In order to obtain the "split-phase" effect. The starting winding, being of smaller wire, has a much higher resistance than the main winding, but, as the number of turns in the two is the same their reactances are equal. Consequently, the ratio of reactance to resistance is different in the two windings and this causes the currents in them to be out of phase with each other. The magnetic fields produced by the two windings are therefore out of phase and combine to form a resultant rotating magnetic field, somewhat like that of a two-phase motor. This rotating field pulls the rotor around with it.

1141. *Is not the starting winding liable to overheat?*

It would if left in circuit continuously, but the rotor contains a centrifugal governor which operates a switch to cut out the starting winding when the speed is almost up to the regular running speed. Then the machine operates as a simple single-phase induction motor.

1142. *What are the advantages of single-phase motors?*

A single-phase motor requires only a single transformer and two lead wires; it can be supplied from any alternating current—single-phase, two-phase or three-phase—and the starting apparatus is of maximum simplicity. The self-starting type has the additional advantage that it can be thrown on and off the circuit from a distance by means of a simple knife switch and if the supply of current should be accidentally cut off, the motor automatically returns to its starting condition and therefore will not be damaged if the current is cut off and restored when no one is around.

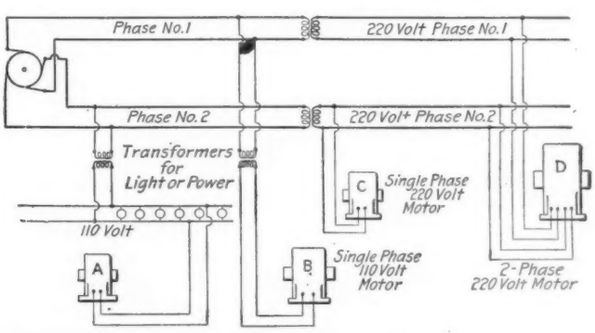


FIG. 372. SINGLE-PHASE MOTORS ON TWO-PHASE LINE

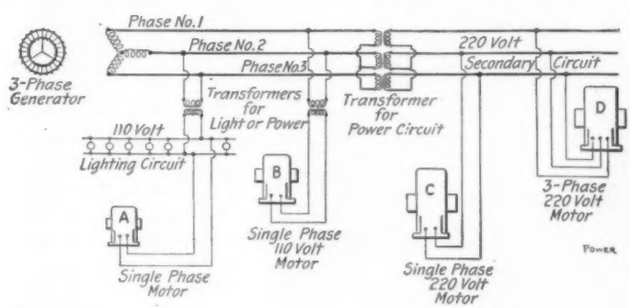


FIG. 373. SINGLE-PHASE MOTORS OF THREE-PHASE LINE

1143. *How are single-phase motors connected to two-phase circuits?*

If the circuit is of the proper voltage for the motor, it is connected directly to either of the two "legs" or phases of the circuit, but if the circuit is a high-voltage primary line, a transformer must be used between the line and the motor; in that case the transformer may be connected to either leg of the supply circuit. Fig. 372 is a diagram showing these methods. The motor *A* is connected directly to a 110-volt lighting circuit which is supplied through a transformer from one leg of a two-phase primary circuit. The motor *B* is supplied through a transformer from the other leg of the same primary line, and the motor *C* is connected to one leg of a secondary 220-volt circuit which delivers current also to a two-phase motor *D*.

1144. *How are single-phase motors connected to a three-phase circuit?*

Each motor is connected to two wires of the circuit, either directly or through a single transformer. Fig. 373 shows connections in which each motor is connected in the same way, relatively, as the motor bearing the same letter in Fig. 372.

1145. *Are there any disadvantages in the operation of single-phase motors on two-phase and three-phase circuits?*

Yes. Both two-phase and three-phase circuits should be balanced as to the division of load between the different phases, and a single-phase motor operated on one phase or leg will unbalance the system. It is important, therefore, to have the same total motor load connected to both legs of a two-phase or all three legs of a three-phase system, and it is almost impossible to get such a division of load with a large number of single-phase motors on either of the systems, especially a three-phase system.

A New Method of Setting Brushes Accurately

By C. A. Boddie

A great deal of the sparking and commutator trouble in direct-current machinery is due to incorrect brush setting. In most industrial plants the voltmeter method of finding the neutral is either unknown or inconvenient.

Those in charge of direct-current machinery usually determine the best brush position by shifting the yoke back and forth until a position of minimum sparking is found. If the brushes are in good condition, they may be shifted through a considerable range before sparking develops. The usual intention is to fix the brushes in a mean position between the forward and backward limits set by sparking. This method is too rough. As long as the brushes are in good condition the machine may run sparklessly even though they are not on the neutral lines; but invisible sparking due to local currents at the brush faces will in time injure the contact surface and visible sparking will result. An examination of the motors of numerous industrial plants shows that the majority of motors are running with their bruhes not set at the neutral lines.

The writer has devised and used successfully a method of setting brushes which does not require expensive instruments or special apparatus. All that is required is a short piece of No. 12 insulated copper wire from which the insulation has been removed for a couple of inches from one end; this end is

Fig. 1. Testing Wire

flattened and tapered to a point, as shown in Fig. 1. It will be found convenient to bend the end backward as indicated. When the machine is running and carrying its regular load, the wire should be brought into contact with the commutator and carefully moved toward the brush until it touches it. Usually the toe of the brush is the edge which sparks, and this edge should be tested first. If the brush spits and glows when touched with the wire, the brushes are not on the neutral line corresponding to the load on the machine.

Both the toe and the heel of the brush should be tested and the yoke shifted until the glowing stops. The brushes on each arm of the machine should be tested. If some spark while others do not, this is an indication that the spacing is not right. If a position cannot be found where the glowing stops, it shows there is something

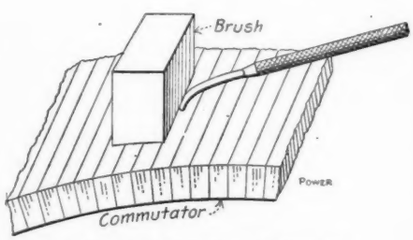


Fig. 2. Method of Testing

wrong in the adjustment or in the design of the machine. Small 500-volt machines and machines having high commutator speed will always spark more or less under this test, but the sparking is very slight if the machine is in good condition, even when carrying full load.

This test is based on the fact that a copper wire simultaneously in contact with the commutator and brush provides a low-resistance path between the two. The carrying capacity at the point of contact on the brush is low, so that if the potential is greater than it should be, enough current flows to heat this point to incandescence.

LETTERS

Mr. Greer's Rotary Converter Trouble

Mr. Greer's description, in the November 15 issue, of the peculiar behavior of his rotary converters interested me very much. For several years I have been operating rotary converters in parallel on both the alternating-current and direct-current sides without intervening transformers on the alternating-current side, and have had abundant opportunity to observe the conditions which arise from this method of operation.

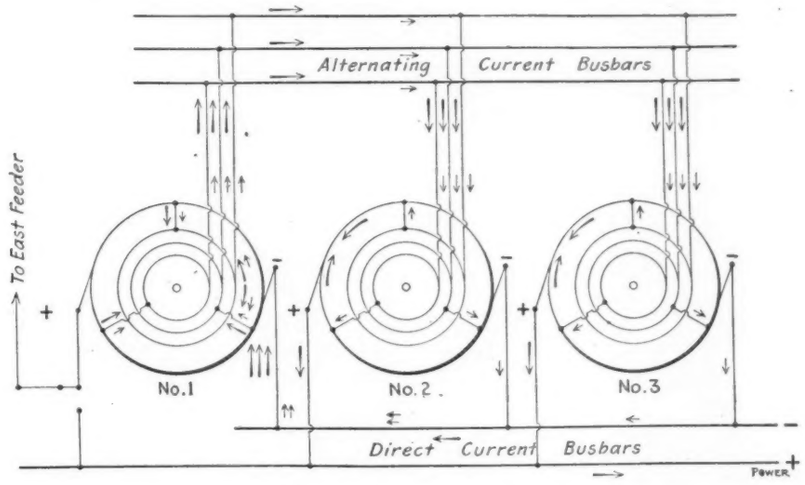
When rotary converters are connected together on both the alternating-current and direct-current sides, a complete local circuit is formed by two converters and the alternating-current and direct-current busbars and a difference in the conditions of operation in the two machines—a slight difference in the relative positions of the direct-current brushes of the two machines, for example—will cause large cross currents to flow in this local circuit and produce many other peculiar conditions, one of which Mr. Greer described.

When two converters are running in parallel under the conditions stated, if one direct-current terminal of one machine is disconnected from the busbar, current will flow in the other lead, provided the direct-current voltages of the two machines are not exactly equal. The direction the current will take through this lead depends on whether the direct-current voltage of that machine is higher or lower than that of the other machine. With the machines I am operating, if the positive and equalizer switches are opened on machine No. 1 (the equalizer is on the positive side), and the field strengthened until a leading current of 94 per cent. power factor is obtained, equal currents will flow in the negative leads of both Nos. 1 and 2. Weakening the field of No. 1 will decrease the current in its negative lead until at 100 per cent. power factor the current is zero and further weakening of the field causes current to flow in the opposite direction—that is, in a positive direction in the negative lead—and at 94 per cent. leading power factor the current reaches the same value as before, but the machine is running inverted.

Mr. Greer's diagram of circuits does not show the direct-current ammeter connections, but the proper connections for them would be in the negative leads and I have assumed that they are so connected. He says that when an attempt was made to run the large machine, No. 1, in parallel with the smaller machines, No. 1 took all the load, indicating that at the busbar connections No. 1's voltage was slightly higher than that of the smaller machines, and this condition would cause all the current from the rail

to pass through No. 1's negative lead and armature, and that coming from the west end passing through the alternating-current leads and busbars to the smaller machines. If Mr. Greer had inserted ammeters in the positive leads of Nos. 2 and 3, he would have found that current was flowing in them to the west feeder and when the direct-current sides of 2 and 3 were disconnected from the busbars that current was interrupted, which accounts for No. 1 dropping the west load and the potential falling to that of the distant west-end substation. The reason the ammeter needles on Nos. 2 and 3 went against the stops was because an equalizing cross current was flowing in the local circuit mentioned above, between the two smaller machines and No. 1.

In the accompanying diagram the paths and directions of the currents from the smaller machine to the feeder and rail through the armature of No. 1 and the alternating-current busbars are shown by the long arrows. The triple arrows on the negative lead of No. 1 converter mean that not only its own negative current but the negative currents of Nos. 2 and 3 are passing through it. The short arrows indicate the path of the cross current in the local circuit.



MR. HARVEY'S DIAGRAM OF CIRCUITS

The resultant current due to the combined direct and alternating currents flowing through the alternating-current busbars was probably alternating in character, though the wave form was doubtless very much distorted. The manner in which the current distributed itself among the collector rings and alternating-current leads varied with each position of the armature. For example, when one wire was carrying the greater part of the direct current the other two wires would probably be supplying the greater part of the alternating current. A study of conditions similar to the above, by means of an oscillograph, would be very interesting and instructive.

S. H. HARVEY.

Hamilton, O.

In the issue of December 20 are three answers to my inquiry concerning the peculiar trouble with rotary converters which was described November 15. Of the three, that of Mr. Farwell is without doubt the correct solution. A more clear and concise explanation would be difficult to find. Mr. McKenney was correct in his statement that the trouble was due to operating the converters from a common set of alternating-current busbars, but the remainder of his explanation is wrong. By reading the description of the behavior of the machines one will see that it was not simply an exchange of current between No. 1 and the others, but that No. 1 actually was carrying the load on both feeders, although the feeders were actually separated at the switchboard because, as Mr. Farwell points out, the machines were tied together through the armatures and the alternating-current leads until separated by Nos. 2 and 3 being taken off the direct-current busbars.

Mr Filkins is wrong in his explanation; the east- and west-end trolley wires were separated by a section insulator. I stated in the article that there was no leak between the east and west end, and this was proved by the fact that the voltage of the direct-current busbars was that of the distant west-end substation (less the line drop) when Nos. 2 and 3 were taken off the direct-current busbars. If it had been as explained by Mr. Filkins the voltage of the direct-current busbars would have been practically that of converter No. 1, since the drop in the feeders to the first trolley tap and that of the trolley wires between the first taps would have been slight.

C. L. GREER.

Handley, Tex.

The Light That Failed

In a certain power plant, which was so small as to require only one attendant, a disagreement arose between the employer and the operator, which so angered the latter that he quit on one day's notice. It was impossible to get an experienced man to take the position in time to keep up the service, so an unskilled laborer was put on the job. The retiring operator refused to give this man any instructions, and it was more by luck than anything else that he kept the plant going for three days. At the end of that time an operator was secured who found no difficulty in understanding the plant, for it was a simple water-power installation of two units.

It was winter and the load was so light that it was unnecessary to run both generators together until one evening in early January, when some slight trouble with the machine in operation caused the attendant to decide to parallel the generators and take the first one off the line. His tracing of the connections had shown him that the synchronizing lamps should be dark when the two machines were in synchronism, and so, after getting No. 2 up to speed, he switched on the lamp, ready to throw the main switch when the lamp darkened. He was surprised to find that the lamp did not glow at all, and after rejecting the supposition that the machines had happened to come into step and stay there, he investigated the lamp and found that it was in good order.

Evidently there was some trouble in the connections of the lamp circuit and as it was therefore impossible to synchronize the generators, he kept the load on the first one until time for shutting down. A very careful search of the lamp connections was made, with the result that nothing could be found the matter with them. As a last resort the synchronizing lamp switch was taken apart, and the source of the difficulty was revealed. A brass strip, intended to carry the current to the lamp, had been filed very thin in one place, and when the metal had contracted in the intense cold of the winter, had pulled apart there.

The fresh appearance of the filed place made it evident that it was the work of the preceding operator. He doubtless expected that the strip would be fused by the current to the lamp when at its maximum; that is, when the two generators were as far as possible out of step. If, when the light went out, the new operator threw the main switch, it would bring the two machines into dead short-circuit with each other, resulting possibly in the destruction of both generators. But for the unforeseen cold snap, this ingenious bit of spite work would probably have succeeded.

HOWARD H. BLISS.

Heber, Cal.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

Some Simple Handy Tools

By James E. Noble

A friend has several tools which cost only a few cents for material; the work of shaping them he did himself.

Fig. 1 is a tapered wedge made of steel, which is useful for separating flanges, prying off cylinder heads, scraping off old packing from flanges, etc.

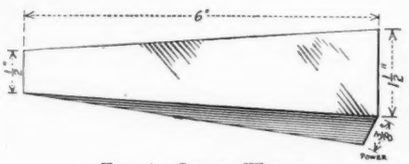


Fig. 1. Steel Wedge

Fig. 2 is a cleaner for gasolene and oil pipes. A piece of steel rope 8 feet long and ¼ inch in diameter is bound tightly near one end with fine wire, leaving about 2 inches of the wire ends to be spread out and act as a brush. A wooden or other handle with a thumb set screw is slipped over the rope and can be set at any point along the length of rope. In using this device, the spread end of the rope is inserted in the gasolene or other pipe and

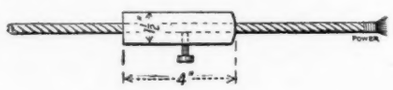


Fig. 2. Oil-pipe Cleaner

the handle is set an inch or so from the end of the pipe and the rope end forced into it; then the handle is moved another inch or two away and the rope forced farther in, and so on. A small pipe is easily cleared of any ordinary obstruction.

Fig. 3 shows a piece of stout wire with a hook formed at one end. It is handy for lifting out springs, picking up anything which may fall in a place difficult to reach with the hand, and so on.

Fig. 4 shows a steel wire with a straight bend at one end, and that end sharpened

Figs. 3 and 4. Packing Hooks

to a point; it can be used to pull out fine packing from packing boxes, etc.

Fig. 5 is a special bit, squared at one end so that it can be used in an ordinary brace or breast drill. The other end is widened out and sharpened as shown; it is especially useful for grinding in small valves and valve seats on gas engines, and for other kinds of work requiring a wide screwdriver blade and extra power.

Fig. 6 is a bolt-hole marker. It consists of a piece of round lead rod with an ordinary iron-pipe cap on one end. In cutting out paper washers as gaskets for gas-engine cylinder heads, some engineers use a hammer to mark the bolt holes, and this sometimes breaks away

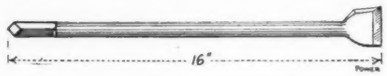


Fig. 5. Screwdriver Bit

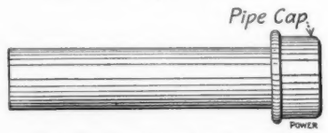


Fig. 6. Bolt-hole Cutter

the sharp edge of the iron around the holes. With this tool you simply lay the paper on the flange, place the lead end over the hole and strike the iron cap with a hammer; the bolt hole will be cut in the paper washer neat and clean. With bolt holes larger than the lead end, it can be used at the opposite side of the flange to mark the holes on the paper far better than an ordinary lead pencil, as the edges are square or sharp at *A* and reach right against the bolt hole.

According to reports received by the United States Geological Survey, the production of coal in the United States during 1910 was between 475,000,000 and 485,000,000 short tons, a considerable increase from the output of 459,715,704 short tons in 1909 and approximately equal to the maximum previous record of 480,363,424 tons, produced in 1907.

Of the total production in 1910 the anthracite mines of Pennsylvania contributed nearly 83,000,000 short tons and the bituminous mines between 390,000,000 and 400,000,000 tons.

Pertinent Features Relating to Gas Power*

By Edwin D. Dreyfus

During the fifteen years of commercial use of the gas engine in this country, abundant experience has been furnished from which may be deduced two features of importance:

1. The distinct fields of usefulness of gas engines may be determined definitely under any conditions, and, in general, are very well defined. Contrary to the frequent implication that gas is a direct competitor of steam power or other source of energy supply, there are unmistakable regions where a gas plant is unqualifiedly superior; and, on the other hand, there are places where it would be a positive economic disadvantage. Evidently there exists a line of division or equality but occasionally encountered, where the decision rests upon probable changes in industrial or operating conditions.

2. Gas-power machinery is less responsive to the ingenious fancy of the designer than the other well known types of station equipment, because the requisite characteristics of satisfactory operation and continuity of service may be satisfied only by a simple and effective design, from which but small deviation is feasible.

The disregard of these factors more than any other cause has been harmful to the gas-engine art. Notwithstanding this, the industry has materially prospered, and, owing to the inherent high efficiency in the conversion of latent thermal energy into useful mechanical power, it will increasingly continue to hold the attention of the engineering profession and commercial world as well.

The available fuels for engine operation are enumerated below and their approximate composition and calorific values are given in Fig. 1.

1. *Natural Gas,* existing principally in western Pennsylvania, western New York, West Virginia, Ohio, Kentucky, Kansas and Louisiana districts. It is a gas of ideal quality, possessing high heat value, being free from suspended impurities and containing only a small percentage of highly inflammable constituents (hydrogen chiefly).

2. *By-product Gas,* obtained mainly from blast furnaces and coke ovens; also from oil refineries as distillate. These gases are, in their crude form, accom-

*Extracts from a paper read before the Pittsburg Railway Club.

panied by objectionable impurities—entrained ore dust in the first two and oily vapors, lampblack and sulphurous compounds in the distillate gas—which must be removed to a reasonable degree by cleaning and scrubbing apparatus before delivery to the engine.

3. *Artificial Gas.* As several different fuels and processes are employed in the

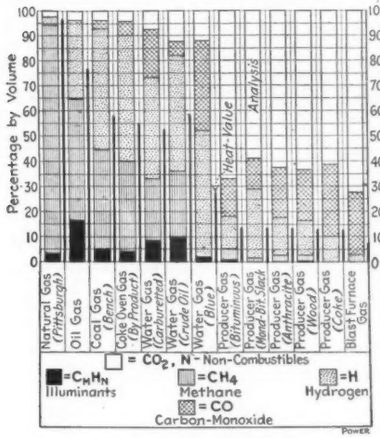


FIG. 1. COMPOSITION AND HEAT VALUE OF FUEL GASES

manufacture of combustible gases, there are several kinds available, such as:

a. Illuminating Gas, produced from coal in benches or retorts by destructive distillation. This is available in practically all large cities; it is of high heat value and is a fairly clean gas. It contains a high percentage of hydrogen which compels the use of comparatively low compression pressures to prevent preignition. The enrichment essential for illuminating purposes and the added expense of distribution make the cost of this gas to the consumer ordinarily so high that its use for power purposes is restricted to very special cases.

b. City Gas, either made from the partial oxidation of coal and carburetted, or from crude oil, possesses the same limitations as illuminating gas so far as the gas engine is concerned. Blue-water gas of somewhat lower heat value and cost, is also less satisfactory and economical than the familiar producer gas.

4. *Producer Gas. A.* The gases made from anthracite and bituminous coals present the logical solution for the use of the gas engine in the absence of by-product or natural gas at low prices.

B. Oil gas producers for power purposes have not yet attained a sufficient degree of development to warrant extended use, but where crude oil is the predominating fuel supply, some installations have been made with fair success.

THERMAL EFFICIENCIES

The foremost characteristic of the gas engine lies in its uniformly high thermal efficiency in all sizes. This virtue is not found in either reciprocating steam engines or steam turbines; therefore, the greatest utility of the gas engine, barring by-product or natural-gas supply, will occur in the smaller operations.

As an illustration, Fig. 2 shows conservative heat requirements in B.t.u. per kilowatt-hour of output for turbines ranging from 500 to 10,000 kilowatts inclusive, and a typical gas-engine curve which applies to all sizes. The latter is based on the total heat of the gas and a gas quality containing a high hydrogen content (lowering the effective value, say 8 per cent.), preferably to place the two types of units on the same plane. It is evident that as the larger capacities are approached, the disparity between gas and steam units steadily vanishes, either plant at best consuming approximately two pounds of coal per kilowatt-hour. Conversely, with a decrease in size of the plant, there is a wider gap between the two types of equipment. Thus the gas plant will continue to develop a kilowatt-hour on two pounds of coal, while the steam station may use eight to twelve pounds.

OPERATING ECONOMY

The impression that gas power invariably implies a lower cost of opera-

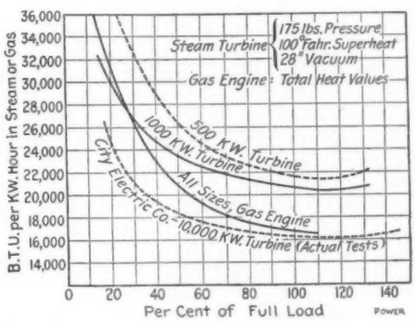

B.T.U. per KW. Hour in Steam or Gas
Per Cent of Full Load
Steam Turbine
175 lbs. Pressure
100° Fahr. Superheat
28" Vacuum
Gas Engine - Total Heat Values
500 K.W. Turbine
1000 K.W. Turbine
All Sizes, Gas Engine
City Electric Co. - 10,000 K.W. Turbine (Actual Tests)
POWER

FIG. 2. HEAT ECONOMY OF TURBINES AND GAS ENGINES

tion is being dispelled through the critical analysis of the elements of power cost. Fuel is manifestly only a fraction of the entire expense. Customarily a division is made between fixed charges, embodying interest, depreciation, taxes and insurance, and the purely operative expense, which includes fuel, labor, oil, waste, water, supplies and repairs. Fig. 3 illustrates the importance of the cost constituents. It is based on plants consisting of two units and burning coal which costs $3 delivered.

The composite cost of a gas-power plant exceeds that of a high-grade steam plant by approximately 30 per cent. Such difference is quite normal in view of the character of working in the two plants. The gas engines must withstand combustion pressures reaching 450 pounds per square inch and corresponding temperatures up to 3000 degrees Fahrenheit, whereas a turbine deals with pressures of 150 to 200 pounds per square inch and temperatures in the neighborhood of 500 degrees Fahrenheit. Moreover, turbines are operated at relatively high speeds and very efficient use can therefore be made of the material employed.

Labor in small gas and steam plants will not differ greatly, but the simple turbine, with its minimum of parts, places a severe handicap on the gas engine when high powers are contemplated, contributing another reason for the barrier against the use of large gas engines for central stations burning coal as fuel. Having the size and cost of the plant, together with the schedule of operating labor and supplies arranged, the decision hinges upon the probable load factor and also upon the price of fuel, where it may be subject to variation. It is an obvious fact that low load factors work against the use of expensive installations, notwithstanding their superior efficiency.

Fortunately for the gas plant, the embarrassment of low-load factor conditions may be partially overcome by the use of a simple low-pressure turbine in conjunction with a heat-storage system supplied by the waste heat of the engine and operated to carry the peak of the load.

Available statistics indicate that the cost of repairs in well designed gas-power plants of moderate size should be about on a parity with those of high-grade steam-turbine stations. That this assertion is reasonable is evident from the fact that the greater cost of cleaning and readjustment of boiler and condenser tubes above the negligible upkeep of the producer largely offsets the increased cost of "conditioning" the gas engine above that of the turbine. Hence fixed charges were arbitrarily assumed equal in plotting Fig. 3.

The real difference in obsolescence be-

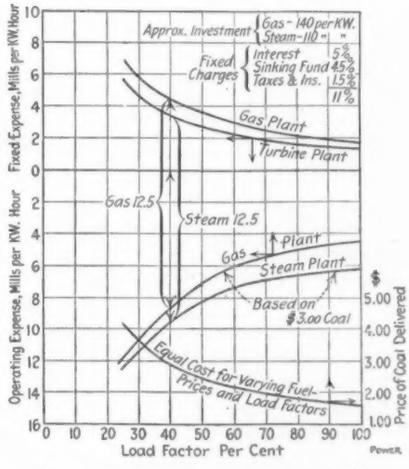


FIG. 3. COMPARATIVE OPERATING EXPENSES

tween the two types of plant is more or less intangible at present, and, therefore, in order to avoid complication, no distinction has been made.

Table 1 is given as an example of the

operating efficiency of a 550-brake horsepower producer-gas plant, including all items of expense:

TABLE 1.

DATA ON 550 BRAKE HORSEPOWER GAS PLANT. MONTHLY RECORD OF OPERATING COSTS, DECEMBER 1909. UNIT LOAD FACTOR 89.3 PER CENT.; STATION LOAD FACTOR, 67 PER CENT.

ITEMS.	CENTS PER KILOWATT-HOUR.	
	Producer Room.	Engine Room.
Fuel	0.202	
Operating labor	0.120	0.036
Repairs { Labor	0.008	0.050
Repairs { Material	0.000	0.002
Water	0.030	0.024
Oil and waste	.....	0.010
Auxiliary power	0.050	.....
Fixed expense at 15% on investment	0.127	0.254
	0.537	0.376
Total	0.913	

AUXILIARY HEATING

Power generation has mainly been reckoned with as applying to central distribution, but in the machine shop, factory and related industries, the power house is subjected to the extra demand of heat supply, especially above latitude 37 degrees. The heating requirement is often improperly allowed to discount the intrinsic value of the gas plant for the reason that the waste-heat energy is not concentrated in the same convenient vehicle for transmission to the point of consumption as is the case with the non-condensing engine or turbine.

More recently gas-engine exhaust heaters have been devised which render available in the form of steam 70 per cent. of the heat of the exhaust. While this quantity represents only two pounds of steam per brake horsepower developed, it will evidently prove sufficient where the ratio of power to steam demand is low. Where the ratio of the pounds of heating steam required per brake horsepower is known, a choice of prime mover may be made as indicated by Table 2.

TABLE 2. POUNDS OF STEAM PER BRAKE HORSE-POWER.

Simple automatic engine	40
Small steam turbine	30
Single cylinder corliss engine	28
Corliss non-condensing compound engine	22
Automatic bleeder turbine	20
Complete expansion turbine (bleeding 25% from receiver)	6
Gas engine (waste jacket and exhaust heat used in hot water system)	5
Gas engine only, exhaust applied to steaming	2

A late report from railroad circles is that the engines on the Pennsylvania lines east and west are to be equipped with automatic underfeed stokers. Orders have been issued to the master mechanics of all the shops to install the stokers as soon as possible. The reason given is that the company wants to live up to the law requiring the abatement of the smoke nuisance. No confirmation of this report has been heard. It is said that 6000 engines will be so equipped.—*Exchange.*

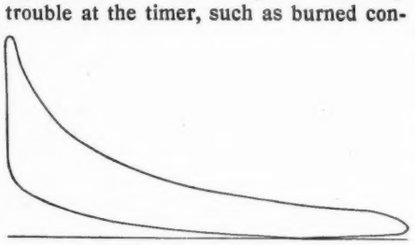
Some Ignition Pointers

BY PAUL C. PERCY

The sudden stopping of a gas engine which has been running normally is almost always due to a breakdown somewhere in the ignition system. With a jump-spark system this may be a broken connection in either the primary or the high-tension circuit; "frozen" contact points on the vibrator of the spark coil, or a short-circuit in some part—any part—of the system. It could also be due to a slipping or broken timer or to slipping of the belt or pulley of the generator if one is used, but these are not so likely to happen as the first three defects.

If the make-and-break system is used there is no vibrator to "freeze," of course, but the other troubles mentioned can occur. The failure to "fire" can also be caused by the contact points of the igniter having been burned out; this will either prevent them from closing the circuit at all or make the electrical resistance at the contact points so high that the current will be too weak to produce a good spark when the contacts are separated.

If the igniter is of the electromagnet type, failure to "fire" may be caused by trouble at the timer, such as burned contacts, loose connections, or a weak spring. It may also be that the rocking contact of the igniter is jammed so that the magnet cannot move it.



A GOOD DIAGRAM

Trouble in the ignition system will also prevent an engine from starting up, of course, but failure to start can also be due to many other causes, whereas a sudden stop is rarely caused by anything else.

Too much current in the primary circuit of a jump-spark system is as bad as too little. It overheats the coil and eats away the contacts of the timer and the vibrator very rapidly and very unevenly. This uneven burning of the points is what causes them to stick together or "freeze." The surfaces are so rough and irregular that they finally touch each other only at a small high spot on each piece of platinum, and the heavy arc produced between the sharp points fuses them together.

To guard against "freezing," as well as other contact troubles, the platinum points of all timer, vibrator and igniter contacts should be cleaned and trued up once a week. This can be done in a very few moments with a sharp, medium-cut file, a very fine file and a piece of emery cloth, using these in the order named. In finishing with the emery cloth it should be backed up by a thin strip of steel, such as a machinist's rule, to avoid rounding the edges. The faces of the platinum points should be left dead flat and true with each other.

If the timing of the igniter be retarded beyond the dead-center position of the crank, the cylinder will almost certainly overheat because the combustion of the mixture is greatly prolonged; also, the power of the engine will be reduced. If the timing be advanced too far, the engine will usually knock, but this cannot be considered a reliable guide because some engines do not begin to knock until the timing has been advanced so far as to be really dangerous.

It is advisable to put stops on the timer mechanism which will prevent retarding the timing beyond the dead-center position and advancing it too far. It is necessary to take diagrams, with the best mixture that will ever be used, to find the point to which the timing should be advanced at full load; the point of maximum advance should be that which gives the nearest approach to a well rounded diagram, such as the one here shown. Sharp corners at the peak and the ignition point on the diagram are not desirable, but with a rich mixture containing much hydrogen it is not easy to avoid them; that can best be done by adding more air to the mixture and advancing the ignition point a little more.

A New Aeroplane Engine

The *Yorkshire Observer,* in an account of a lecture delivered before the Leeds University Engineering Society, by R. J. Isaacson, gives his claims as inventor of an improved aëroplane engine, as follows:

He stated that his new engine was based on the same general principles as the Gnome, but embodied many of his own devices, notably one which enabled the engine to be started slowly and run at almost any speed up to its maximum that the aviator wished. This was a vast improvement, because with all machines in use at present it was only possible to work at one speed, and that the highest. Therefore, when an aviator, having attained a considerable hight, wished to descend, he must shut his engine off altogether. But if the propeller once stopped revolving it was impossible to restart the engine without help, and therein lay the reason for the awe-inspiring volplanes, by which aviators descended from great hights. It was necessary to descend at a great speed, so that the force of the air against the propeller might keep it in motion in order that when the aviator neared the ground he might restart his engine, and thus control his movements. Mr. Isaacson claimed that the use of his engine would obviate all necessity for volplaning.—*Daily Consular and Trade Reports.*

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Water Control Valve on Heater

Much worry and trouble are caused by the automatic valve which regulates the flow of feed water into an open heater. I know of no valve of which so much is expected. It must work so freely as to be handled by an ordinary float, it must move from a closed position to wide open during the movement of the float, and it must shut perfectly tight.

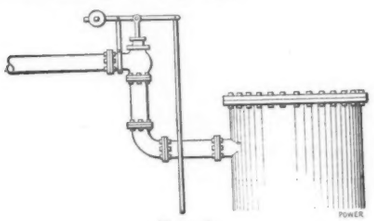


FIG. 1.

I have tried several valves, one of which was made as shown in Fig. 1. The 20-foot head under which it worked would, however, hold it shut until the float was held almost clear of the water. Then, when the valve did operate, it opened wide with a jump and almost deluged the heater with water; in closing it would shut with a vicious bang as soon as the valve got near enough to its

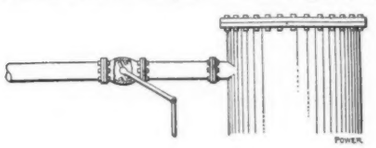


FIG. 2.

seat to be caught in the current of water. Sometimes it would pound on the seat 30 or 40 times before seating.

The second valve I tried was of the butterfly type, shown in Fig. 2. It had just one fault; it would leak in spite of all that could be done, and if no water was drawn for an hour the heater would be flooded.

Another valve I tried was an ordinary globe valve rigged up as shown in Fig. 3. The fault of this valve was that, although it worked freely, it did not open enough

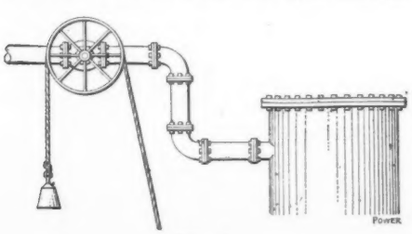


FIG. 3.

during the travel of the float, and very often small particles in the water would wedge in between the disk and seat and prevent the valve from closing tight.

Another valve was made from an ordinary brass stop cock with a handle attached, as shown in Fig. 4, but I found that, while it had all the good features of shutting off tight, not clogging, and opening quickly and fully with a small

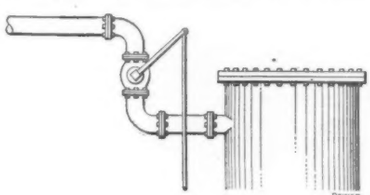


FIG. 4.

travel, it was too stiff to be operated by the float, and if it was loosened up so that it could be operated by the float, it would leak at the washer on the small end. Finally I removed the nut and washer,

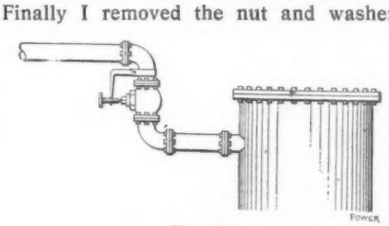


FIG. 5.

threw them in the scrap box, and then cut off the small end of the plug so that it lacked ¼ inch of coming flush with the seat on the body of the valve against which the washer had fitted. Then a small brass disk was soldered over the small opening of the body, making it similar to a marine cock. This put an end to the leakage at the small end of the plug. In order to hold the plug to its seat, I rigged up the pointed spring shown in Fig. 5. The point of the adjusting screw rests in the center plate on the plug and is so arranged that the pressure could be varied. This meets all requirements as it works free, shuts off tight, opens and closes with a small movement and is not affected by the pressure or water head it is controlling.

R. MANLY ORR.

Brantford, Can.

Estimating Refrigerating Surface

It is often convenient to know the amount of piping required for brewery cellars and the like.

Without knowledge of all of the elements effecting the cold losses from a cold-storage compartment, only general statements can be made, which, while probably fitting the general case, might fall wide of the mark in any isolated special case.

The logical way of computing pipe areas is first to calculate the amount of heat entering through the walls of the cellar and add to this the amount of heat generated by the fermenting wort. For a given back pressure and known number of hours of operation of the refrigerating machine, it is then a simple matter to calculate the amount of pipe required. The estimate of the pipe area is based on the amount of heat that will pass through the metal of the pipe due to the difference between the temperature of the brine or ammonia on the inside and that of the air on the outside.

Obviously, the amount of piping depends on the wall area, insulation efficiencies and differences in temperature. When these factors are not all known, it has been customary to employ rough rules in the form of "ratios" by which it is assumed that under average conditions a square foot of pipe surface or

RATIOS FOR BREWERY CELLARS.

Kind of Service.	Cubic Feet per Foot of Piping, Rooms 1000 to 4000 Cubic Feet.			Temperature.
Fermenting room	2″ direct-expansion pipe	13.5	to 14.5	36°–40°
	1¼″ brine pipe	7.5	to 8.5	
Storage cellar	2″ direct-expansion pipe	21	to 26	32°–34°
	1¼″ brine pipe	12	to 16	
Chip cellar	2″ direct-expansion pipe	24	to 30	34°–36°
	1¼″ brine pipe	14	to 18	
Racking room	2″ direct-expansion pipe	12	to 15	34°–36°
	1¼″ brine pipe	7	to 9	

running foot of pipe will provide refrigeration for a given number of cubic feet of space. A fermenting room, for example, maintained at a temperature of from 36 to 40 degrees would be piped, according to the practice of one large builder of refrigerating machines, on a ratio of 1 to 14; that is, 1 running foot of 2-inch direct-expansion pipe for every 14 cubic feet of space.

For piping the different cellars in a brewery, the following ratios will offer at least a rough guide, it being understood that they may not fit particular cases and that it is desirable, when it is possible to determine the areas, differences in temperature and nature of the insulation of each wall, floor and ceiling, to compute the cold losses through the walls. Then, after determining the ammonia back pressure and temperature, the required number of square feet and finally the number of lineal feet of heat-absorbing pipes may be ascertained.

The accompanying table will serve as a guide in laying out the piping for brewery cellars of from 10,000 to 40,000 cubic feet in size.

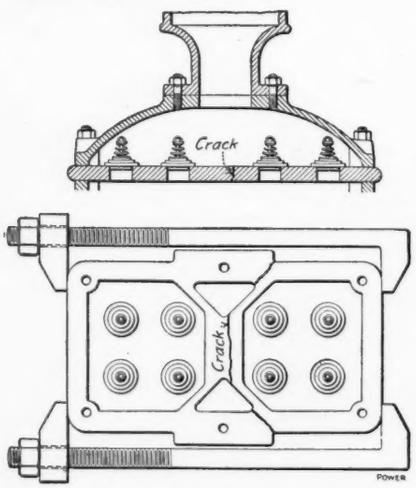
F. E. MATTHEWS.

New York City.

Repairing a Pump Valve Deck

Upon taking charge of a steam plant at one time, I found a broken pump, and nobody knew what ailed it.

Upon removing the cap of the valve chamber it was found that someone, in removing the water-valve plate, had cracked it, as shown in the sketch. This crack was caused by driving a cold chisel under the plate at one end.



CRACK IN VALVE DECK

The plate was repaired by getting two iron clamps from the stop and putting the two broken pieces in place, as shown. A small strand of asbestos wicking was put between the two broken pieces, and the clamps were then tightened.

Next, the top of the valve chamber was put in place and the nuts tightened on the stud. The clamps were then taken off, the pump started, and kept in operation for six months. In the meantime a new plate had been ordered.

In removing a valve plate, use two thin chisels, driving them in slowly, and use a thin knife blade to work the gasket loose before the plate is removed.

CHARLES L. NEFF.

Little Rock, Ark.

Topics for Discussion

After reading mechanical papers and books, I have been able to find but little on the design of breechings for boilers. One thing especially was noticed, the lack of discussion of draft losses.

There are a few subjects I would like to see discussed, and I believe they would be of great benefit to many engineers. They are as follows:

The proper area of a breeching for boilers to be operated at the builder's rated capacity; and for boilers to be operated at high overloads, say 175 per cent. or more of their rated capacity.

Draft losses to be expected in a breeching of excellent design.

Draft losses through the sharp angle turns or sudden changes in shape of the breeching.

Losses in draft, due to radiation, in long runs of bare steel breechings.

Losses in draft due to the cooling of gases by the infiltration of cold air in brick breechings.

One case is that of a plant of three boilers and a brick-lined steel stack, 56 inches in diameter and 135 feet high. The stack was of sufficient size and hight to furnish draft for the plant, yet there was insufficient draft. Eventually an induced-draft outfit was installed with the fan arranged to "pull" on the stack. The draft at the base of the stack was then 1.85 inches; on the stack side of the damper, 0.40 inch; and over the fires, 0.17 inch. Later the breeching was altered and some other changes made, all on the stack side of the boiler. Now it is possible to get a natural draft at the base of the stack of 0.83 inch; stack side of the damper, 0.65 inch; over the fires, 0.23 inch. Better conditions can be had by a little more effort.

It will be noted that after the changes there was more draft available over the fire than before. The alterations were made between 9 p.m. Saturday and 4 a.m. Monday, for four consecutive weeks and cost about $800. The motor on the induced fan took 90 amperes at 220 volts, working 24 hours a day, six and a half days a week.

In another case sixteen 400-horsepower boilers delivered their flue gases to a brick breeching. The temperature at the damper was 550 degrees Fahrenheit and at the stack 380 degrees Fahrenheit. Quite a decrease.

Another case was that of three water-tube boilers. The draft in the breeching near the stack was 0.95 inch; on the stack side of the damper, 0.40 inch.

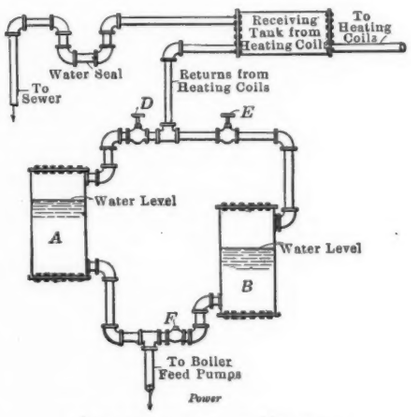
S. H. VIALL.

Chicago, Ill.

Heater and Piping Arrangement

A scheme of arranging two feed-water heaters so that the feed pump can automatically draw water from either heater is shown in the illustration. This arrangement also remedied a trouble experienced from air leaking into the drip receiver of a Paul heating system.

Referring to the cut, *A* and *B* are two open feed-water heaters, and *A* is set 17



ARRANGEMENT OF HEATERS

inches higher than *B*, and receives all of the returns from the heating coils, the valve *D* being open and *E* closed. When there is a sufficient supply of return water the greater head of water in the heater *A* keeps the check valve *F* closed, the water level in *B* being kept constant by a float in the heater *B*, but as soon as the returns are not sufficient to supply the boilers and the water level in *A* falls to a point where the head of water in *B* becomes greater, this heater will furnish the boilers with feed water; heater *B* receives its supply of water from the service mains.

As soon as the returns have again brought the water in *A* to such a level that the head will overcome that in *B*, the check valve *F* is closed and the pump again takes its supply from the heater *A*.

This scheme is entirely automatic and has been in service for over five years, and has given excellent satisfaction.

Trouble had been experienced by air leaking into the receiver in which the condensation from the heating coils accumulate. When air leaks into the receiver, through the joint of the cover, a pressure was established and the water in the receiver would back up into the heating coils, rendering part of the coils useless. The cover of the receiver was tapped out to receive a ¼-inch pipe and a pipe and a thermostatic valve were

connected to it. A connection was also made from the valve to the regular pipe line leading to the exhauster of the system.

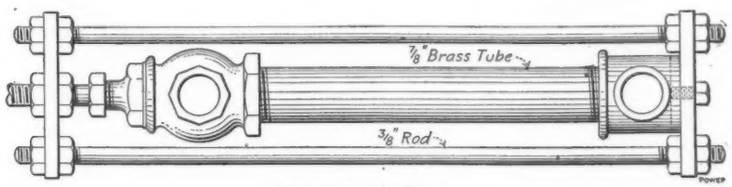
V. T. KROPIDLOWSKI.

Winona, Minn.

Homemade Trap

Following is a description of a steam trap that was made with material found lying around the shop. The idea is not new, as I installed such a trap nearly 20 years ago, still I thought, in view of its extreme simplicity, that it might interest someone, as it is perfectly reliable and satisfactory.

The illustration is so clear that a further description is hardly necessary, further than to say that the threads on the valve stem are removed to allow free movement through the stuffing box as the brass tube expands. As the brass tube fills up with water it contracts and draws away from the valve seat, thereby allowing the water to escape. When the water has drained out of the brass pipe it fills with steam, which causes the pipe to expand and close the valve.



DETAILS OF TRAP

GEORGE J. LITTLE.

Passaic, N. J.

Valves in Steam Pipes

Notwithstanding the extensive discussion that has been carried on in technical papers concerning placing valves in steam pipes, as good an authority as William Kent, in his eighth edition of "Mechanical Engineers' Pocket Book," just issued, in his article on "Valves in Steam Pipes," page 852, seems to be under the impression that if a globe valve is connected with the pressure on top of the disk it cannot be repacked under pressure.

As a matter of fact, most valves of good manufacture today are equipped with a packing feature on the stem and in the hub, or on the yoke, which enables the engineer to pack the valve when it is wide open and under pressure. This feature consists of two finished surfaces, one on the stem and one in the hub, or on the yoke, which make a joint when the valve is opened wide so that there can be no leakage up through the stuffing box.

I notice further in this same article that Mr. Kent fails to bring out one point against taking the pressure on top of the disk and that is that in opening the valve it is necessary to lift the weight of the entire steam pressure on top of the disk, which is almost as much a strain on the threads as holding the disk down when the pressure is underneath.

E. G. GREENMAN.

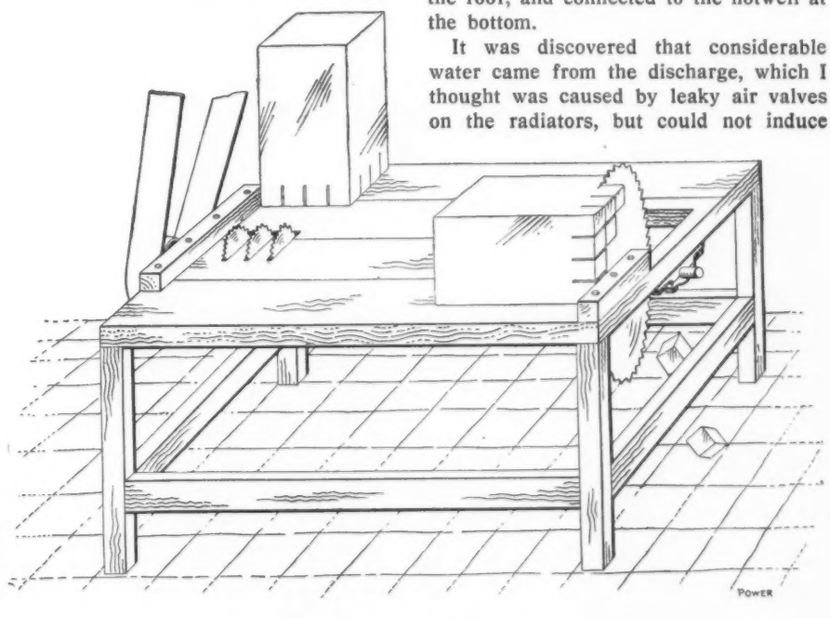
Cincinnati, O.

An Ice Cubing Machine

I was employed for some time at a plant where part of the equipment consisted of a refrigerating outfit. The ice manufactured was in the so called 50-pound blocks, 8 inches square by about 25 inches long.

About this time the manager decided that it was necessary for us to supply the ice to several of the departments in the form of small cubes about 2 inches square. There are machines on the market for doing this work, but the company seemed unwilling to go to the expense of purchasing one, and we were told to make one.

After some planning it was decided to erect a saw bench and use power-driven circular saws to do the work. A carpenter built a stout frame in a convenient position close to a line shaft.



MACHINE FOR CUBING ICE

While this work was being done, a 6-inch pulley, three small saws, 8 inches in diameter, and one larger saw, 20 inches in diameter, were procured and secured to a small 1-inch shaft, 4 feet 6 inches long, as shown in the illustration. When the frame was finished the shaft was placed in proper bearings which were secured to the frame. A hard-wood top was made, and slots cut in it for the saws to come up through.

With the top in place the small saws protruded 2 inches at the highest point and the large saw showed a full 9 inches. The slot at the large saw was made large enough to allow the cubes to drop through when sawed off.

A guide was placed 2 inches to the left of the small saws to be used as a gage when cutting.

To operate this saw the block of ice was placed on end and pushed across the small saws, making three cuts in the block 2 inches deep, dividing it into four equal parts. The block was then turned half round and the saws run across the block at right angles to the previous cuts. The ice then appeared something like the sketch.

The 20-inch saw was used to cut these cubes from the block.

WILLIAM WATT.

Lambton Mills, Can.

Saved Water from Heating System

For more than a year I have had charge of a plant where much of the steam is used for heating through a vacuum system. The vacuum was maintained by a double steam jet and the discharge was led to a soil pipe which went out through the roof, and connected to the hotwell at the bottom.

It was discovered that considerable water came from the discharge, which I thought was caused by leaky air valves on the radiators, but could not induce the management to get new ones, so I connected the vacuum pipe from the heating system to a pump-exhaust pipe leading to a condenser.

It was found that by this method a higher vacuum could be maintained on the heating system than with the jet and also save 1000 gallons of hot water daily.

E. V. CHAPMAN.

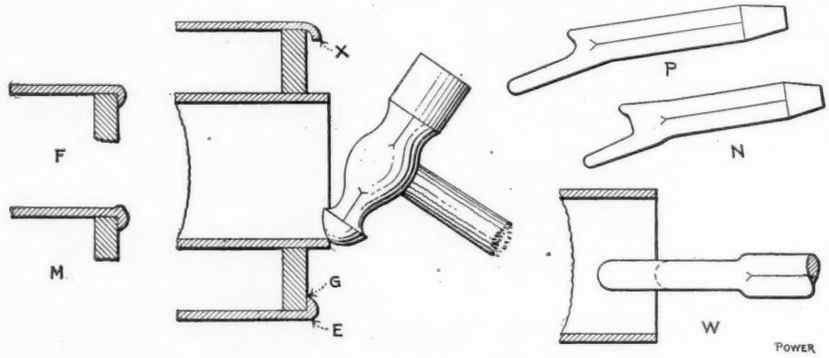
Decatur, Ill.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Beading Boiler Flues

In reply to the inquiry in the December 13 number in reference to beading boiler flues, I will say that there is much more skill needed in doing this work properly than is generally considered. As to beading the body of the head down solid, there is no reason why this should not be done. Care must be used, however, not to overbead. When the head is once solid upon the flue sheet any more hammering or beading will stretch the head and tend to loosen it from the plate. The turning of the head should be carefully done from the start. Many workmen start a bead too hurriedly or use too heavy blows. With the ball end of an ordinary hand hammer used as shown in the accompanying figure the bead can be turned nicely. The hammer strokes should not be too heavy, but moderate, until the bead has been started or slightly turned. Flues are too frequently cracked by hammering too much at one point. It is the peening-action of the hammer that stretches the end of the flue; therefore the "licks" must be distributed entirely around the circumference of the flue in order to stretch it evenly. When this has been done (it is fully understood, of course, that the flue has been previously rolled tight in the sheet) the turned edge of the flue will appear as shown at *X* in the illustration.



BEADING TOOLS AND TYPES OF BEAD

When this has been done the tube is ready for an application of the beading tool. This tool should be properly shaped in order to do the right character of work; for instance, the surface that comes against the end of the flue should be slightly rounded as shown at *W*. With this shape the tool has a stretching effect on the metal. Another view of the tool is given at *P*. It requires a little practice in order to get this little tool just as it should be. Many repairers get the tool shaped as shown at *N;* such a tool makes a poor job, as the surface is too square to do good beading.

Heads are often found that are not properly done; they appear as shown at *M*. A small ridge is thrown up on the inside. In such a case it would be well to use the flue roller.

At *F* is shown a nice form of bead which can be made with a tool like that shown at *P*. Many beads are shaped as shown at *E*, having a rather square corner. With such a bead the edge of the flue does not fit against the edge of the sheet as will a bead shaped as shown at *F*.

To do a beading job properly the sharp edge of the tube hole in the sheet should be taken off with a flue-hole reamer or a half-round file.

I can see no reason for throwing the edge *G* down tight against the head and not beading solid. The beading tool should not reduce the thickness of the metal across the point of turning. One should not attempt to turn a flue that reaches through the sheet too far; usually a distance equal to twice the thickness of the metal is about right, although in some cases three thicknesses is better. If the tube is allowed to stick through too far a bad piece of work will result, as a bead will be formed which will be too full; consequently it is very likely to crack or split in turning down.

Putting in a set of flues and doing the work right is a nice piece of work.

C. R. McGAHEY.

Baltimore, Md.

Compound Engine Proportions

A. Hoffmann, in an article under the above caption in a recent issue, makes certain statements which are not quite clear to my mind, and with the expectation of receiving more light, I wish to open a discussion on this interesting subject.

In one paragraph he states, "Where both reheater and steam jackets are used, 10 per cent. should be added to the mean effective pressures." Directly below this he writes, "Where an engine operates against a back pressure, the mean effective pressures should be increased about 0.85 pound for each pound of back pressure." The use of reheater and steam jackets is known to be beneficial to the performance of an engine, but is it to be implied from the latter quotation that back pressure is also good?

Further on, he says, "Attention is called to the fact that this terminal pressure is not dependent upon the cylinder ratio nor the cutoff, but is determined solely by the steam pressure and ratio of expansion * *." Is not the latter entirely dependent upon the other? Assuming a compound engine having a cylinder ratio of 4 to 1, with a point of cutoff at 0.25 of the stroke, is it possible to raise or lower the terminal pressure in the low-pressure cylinder under the conditions, assuming normal conditions and neglecting cylinder condensation? In a worked-out example for a highly economical compound engine Mr. Hoffmann states that the cylinder ratio should be 5 to 1, and that the cutoff (presumably in the high-pressure cylinder) should be 27.5 per cent. of the stroke, and that the number of expansions should be 19. Under these conditions, will not most of the expansions take place in the low-pressure cylinder (or in the receiver) and, in consequence, will not the condensation there be abnormal? F. R. Low, in his treatise on the compound engine, teaches us that it is not the total amount of condensation in both cylinders that must be reckoned with, but the greater

amount in either, which becomes the factor in the economy of a compound engine.

Suppose a compound engine with cylinders 20 and 40 inches in diameter to be working under conditions that cause a cutoff in the high-pressure cylinder at about 0.2 of the stroke, is it to be understood from Mr. Hoffmann's remarks that if a higher cylinder ratio were used, by making the high-pressure cylinder 18 inches in diameter, that the engine would operate under more economical conditions? It seems to me that his method of proportioning compound engines by arbitrarily fixing the mean effective pressure as referred to the low-pressure cylinder is not commendable, for, as he states, "no definite rule can be laid down giving the proper mean effective pressure upon which to figure." As users of compound engines buy this type with economy of operation in view, and as pounds of steam per horsepower delivered is the true measure of engine economy, why not start designing with this one factor alone given? Suppose a compound engine of a given indicated horsepower were to be designed that should use a predetermined or given amount of steam per horsepower, the total amount of steam could be calculated, and from this the size of the steam pipe, steam chest and valve posts to accommodate that quantity of steam without wire-drawing could be figured. Also, the size of the high-pressure piston and the distance from the heads at which it shall stand at the point of cutoff could easily be determined. Proportioning the rest of the engine would then depend on the price the purchaser wished to pay. The price would determine the length of the stroke and the cylinder ratios.

The designer is in a position to give the buyer what he wants, and by having a high-pressure piston which is more or less of a standard, he will soon be able both in theory and practice to state exactly what the engine is capable of doing when installed, and to quote prices and the degree of economy that he could guarantee with the various cylinder ratios. To design a compound engine based on a given mean effective pressure referred to the low-pressure cylinder or the ratio of expansion, is to forget that the operating engineer is very apt to change the number of effective expansions, and to forget that pistons, valves, etc., are apt to leak.

The reputation of an engine is not made while the engine is brand new, but after some years of service. If the high-pressure cylinder is designed first, then some consideration of future troubles may be employed in the low-pressure cylinder.

N. CASSIDY.

South Framingham, Mass.

Problem in Expansion of Steam

At the present time, when, in technical studies, discoveries are so frequent, and often of so revolutionizing a character, it is necessary for an engineer who wishes to keep abreast of the age to read a large number of technical papers. From the force of circumstances he must read

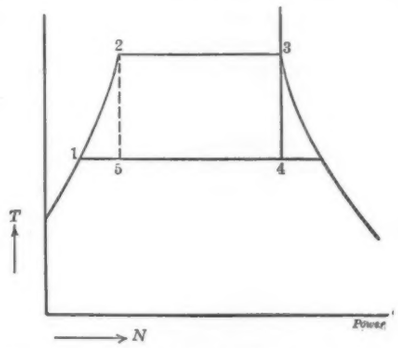


FIG. 1. TEMPERATURE-ENTROPY DIAGRAM

rapidly, and he feels, consequently, that he has a right to demand that these articles be written with especial care; that they be so worded as to leave no shadow of a doubt as to their meaning. It is not fair for the author to expect his reader to puzzle out from indefinite English an important technical fact. Yet not all scientific articles are so written, and in consequence—both of the hasty reading and the poorly stated facts—many wrong conclusions are drawn, and a body of faulty ideas allowed to spring up. Examples of such articles are numerous, but the present writer was impressed with this need for guarded and accurate expression most recently in connection

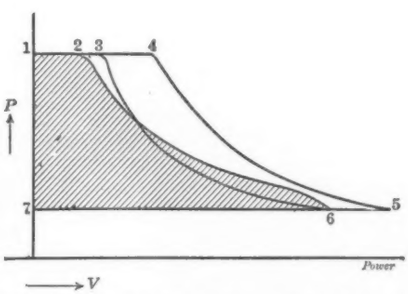


FIG. 2. DIAGRAMS FOR IDEAL ENGINE AND FOR ACTUAL ENGINE

with an article by Mr. French in the December 13 issue of POWER.

Mr. French makes such reference to the Carnot and Rankine cycles as to seem to indicate that they are identical. Now the Rankine, or nonconducting steam-engine cycle may be represented by the area 12341 on the *T N* diagram, Fig. 1. The Carnot, or purely theoretical, cycle may likewise be represented by the area 23452. The difference is in the left of the diagram and is due to the necessity of heating up the feed water in the boiler instead of compressing adiabatically from the lower temperature to the upper temperature.

Mr. French goes on to show that an "exact solution" of his problem (i.e., to find the volume of steam at the end of a certain number of expansions in the steam-engine cylinder) can be found by "assuming" adiabatic expansion and figuring for the quality of steam and its corresponding volume. This is perfectly correct, if everyone understands that an ideal Rankine cycle is being considered, but not otherwise, and Mr. French did not make it clear that he meant the former.

The solution of problems similar to those just cited depends, therefore, on what assumptions are to be made. The Carnot cycle is unattainable (although several pumping engines have used cycles having very nearly that efficiency), and while we continue to use metallic cylinders we cannot hope to get a nonconducting engine, but we can reduce radiation and conduction greatly, by using small temperature limits, by polishing

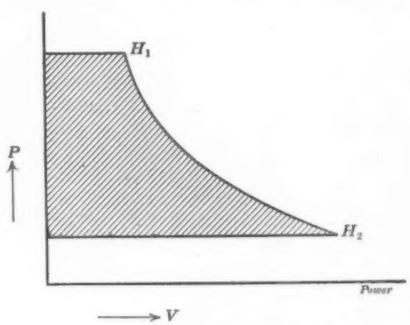


FIG. 3. DIAGRAM FOR THE RANKINE CYCLE

the cylinder heads and barrels, and by other methods of like nature. It is usual in academic problems to assume a Rankine cycle and to figure as Mr. French has indicated, but this must be understood as being purely a first approximation to the correct answer.

In the ordinary steam engine, cylinder condensation and subsequent reëvaporation alter the condition of affairs decidedly. This can be shown by Fig. 2, where 14571 shows the work that could be done in an ideal nonconducting engine, by the actual steam admitted to the cylinder. Likewise 13671 represents the ideal amount of work obtainable from the steam accounted for as dry at cutoff. In distinction from these ideal areas is that of the actual work, shown on the diagram by the crosshatching. The difference between the areas 12671 and 14571 shows the loss in work due to cylinder condensation, radiation, leakages and other losses. The actual volume at the end of expansion is also much less, for the same amount of steam, with the actual cycle than with the ideal cycle.

The actual cycle is affected by a number of factors each varying the work attainable, and the volume at the end of expansion. These are, in part—the temperature range, the per cent. cutoff (the ratio of expansions), the ratio of diameter to stroke, the speed, the clearance and the quality of the steam. The temperature range has the greatest effect on the cylinder condensation, but this is modified by high speed, by small ratio of diameter to stroke or by superheat.

What has just been said shows the impossibility of foretelling how the steam in the cylinder will behave unless some assumptions are permitted as representing typical results, and so we return to the assumption that the real steam-engine cycle is approximated closest by the Rankine cycle. The work done in such a cycle is $H_1 - H_2$, where H_1 is the total heat of the entering steam, and H_2 is the total heat of the exhaust.

Other problems involving total heats are the throttling-calorimeter problems, flow of steam, expansion valves and others involving adiabatic expansion. These problems are greatly simplified by the use of the Mollier total-heat diagram, such as is very admirably given in Marks and Davis' "Steam Tables and Diagrams," a recent publication based on the very latest experimental data. With these diagrams, problems like the above, and also those involving ratios of expansion, are simplified extremely, and made capable of quick solution.

H. J. MITCHELL.

Cambridge, Mass.

Power Plant Design and the Operating Engineer

The controversy regarding the operating engineer and the consulting engineer has been waged in the columns of POWER for some time. It seems to me that this question as to which is better qualified to design a power plant is entirely uncalled for for the following reasons:

In the small-sized plant where the chief engineer has only one or two helpers, he generally does not get a very large amount of money for his services. As a consequence, a man broad enough to design a new plant, under the best conditions, would not be working at the small salary which that plant warrants. As a consequence, the consulting engineer is called in.

In the large plant, where the chief engineer is something more than the name sometimes implies, there is generally a good mechanical engineer employed steadily by the management, or the head engineer is himself a mechanical engineer. In the latter case, as both are one, there is no cause for argument. In the second case, if the management is good, with no friction between the employees, the chances are that the two would work together and no outside man would be called in.

Any mechanical or consulting engineer would welcome the advice of a capable man who is to have charge of the plant. On the other hand, the chief engineer should certainly welcome the advice of the technical man who, of necessity, makes himself acquainted with the general trend of progress in his line. With two good men working harmoniously together the results should certainly be better than with one alone.

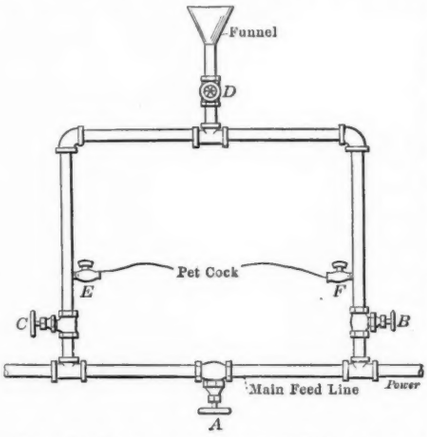
The consulting engineer who knows it all and will not listen to suggestions is not worth having. The running engineer who is afraid to have his ideas criticized by others is certainly not sure that his design is the best under the circumstances. The employer who employs one or both of the above men and brings in an outsider for this work shows a lack of confidence in his own men. If the lack of confidence is unwarranted the best thing the employees can do is to go elsewhere. If it is warranted, the men should realize it and make the best of it.

JOHN BAILEY.

Milwaukee, Wis.

Introducing Solvents into Boilers

In the issue of December 6, Charles H. Taylor's letter under the above title is interesting. I agree with Mr. Taylor that solvents should be introduced in small quantities, but it is poor practice to feed them through the suction of the pump. This practice is liable to result in a scored lining of the water end, scored rods and cut packing.



ARRANGEMENT FOR FEEDING SOLVENTS

A much better way is to feed the solvent through the discharge. The accompanying figure shows the manner in which this can be done. Close valves *C* and *B*, open valve *D* and put in a charge of the compound. Close valve *D* and open valves *B* and *C* and close valve *A* for a few strokes of the pump.

M. W. UTZ.

Minster, O.

Boiler Efficiency

The efficiency of the Keeler water-tube boiler as reported in the issue of November 29 is exceptionally good; however, it is to be regretted that having so nearly attained maximum efficiency the plant was not arranged to insure getting it.

The temperature of the escaping gases was 473.62 degrees Fahrenheit. This temperature could not be appreciably reduced by enlarging the heating surface of either the boiler or the superheater, the temperature corresponding to the pressure of 188 pounds being 383 degrees; the difference in temperature between the fire-swept and water-swept surfaces of the tubes is 90 degrees. It would be possible, however, to reduce the temperature of the gases by installing an economizer and it should be quite possible with a normal size of chimney to reduce this temperature by 100 to 120 degrees, without impairing the draft. If this were done, then, the gases would impart an amount of heat to the feed water which would depend upon the size of the economizer.

From my calculations it should be quite possible, from the figures given in the test, to so arrange an economizer that an overall efficiency of 80 to 89 per cent. could be obtained from the boiler, superheater and economizer.

It appears that the feed water is at present heated by live steam to 183 degrees Fahrenheit, if this is correct, then the installation of an economizer would save the large amount of steam that must be necessary for this purpose besides effecting the above mentioned saving of 6 to 7 per cent.

It is seen that the makers guaranteed a boiler efficiency of 65 per cent.; from the figures given in the test, it is found that the actual boiler efficiency was nearly 75 per cent., the efficiency of the boiler and superheater together being 82.36 per cent. It is to be hoped, however, that a munificent government paid the bonus upon the latter figure, for the attainment of an efficiency of 75 per cent. with a water-tube boiler is a noteworthy performance.

The attainment of this high efficiency is, no doubt, partly due to the efficient way in which the boiler was incased. The makers' guarantee of a 65 per cent. efficiency, however, is about 5 per cent. lower than is usually obtained.

This test is very instructive and valuable for power-plant engineers as it shows the actual saving in fuel that can be accomplished by a superheater in conjunction with the boiler, and, as is well known, this is not the only saving that is accomplished, for, by superheating, the steam condensation in the steam pipe is prevented, and a great saving in the steam used by the engine is effected if it works with superheated steam.

JAMES CANNELL.

Stanford le Hope, Eng.

Does the Crosshead Stop?

Although considerable space has already been devoted to the subject, "Does the Crosshead Stop?" it would be transgressing the requirements of accuracy to let the most unmathematical contribution of Messrs. Stover and Pullen, in the January 3 issue, pass unchallenged. It is merely a problem in the elements of trigonometry to show that the crosshead does actually stop, that is, that its velocity for an infinitesimal moment is zero, but your contributors have gone out of the way to give three different proofs, not one of which is valid.

By reference to Fig. 1, reproduced from the January 3 issue, we are told that the crosshead stops because at the point of dead center the crank-pin center is moving along an arc of a circle described with point H_1 as its center. This, of course, assumes that H_1 will remain

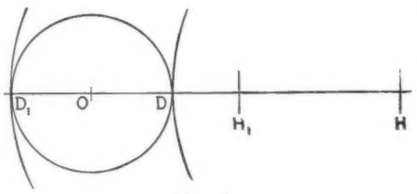


FIG. 1.

fixed while the crank-pin center is moving along this arc. But, if we do not know whether the crosshead stops or not, how can we assume that H_1 is fixed while the crank pin is moving? This is reasoning in a circle.

In proofs 2 and 3 your contributors have attempted to show that the crosshead-pin center has no motion parallel to its axis at the dead center, because the crank-pin center has then no motion parallel to the same axis. That this is not a valid proof may be easily shown by reference to Fig. 2. Here we have a rod $A\,B$ sliding along, so that its extremities

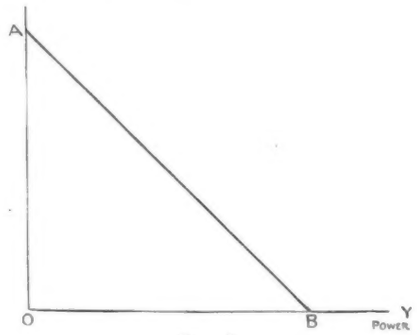


FIG. 2.

always touch two perpendicular axes. At all times, point A has no motion parallel to $O\,Y$, yet it is obvious that point B is always moving along the axis $O\,Y$.

By simple trigonometry, however, it is proved that the velocity of the crosshead center is at any time equal to the angular velocity of the crank pin (which remains constant) multiplied by the perpendicular distance from the crank-shaft center to the connecting rod. At the point of dead center this distance is 0 (see Fig. 1), which makes the velocity of the crosshead center

$$a\ constant \times 0 = 0.$$

This is the only way that I can see of attacking this problem, because this solution deals with the velocity of the crosshead center, which is the only point under consideration, as we know that the crank-pin center is revolving at a constant velocity.

LOUIS GROSSBAUM.

New York City.

Why Engineers Do Not Write

The question often raised in regard to why engineers, as a class, do not write, may be answered in various ways, each truthfully. I believe that chief among the reasons is the fact that the average practical operating engineer who is not a technical graduate fears that his words may sound uncouth or that his statements may be criticized from an angle from which he is incapable of viewing them before presentation and that if his communication be published a later copy of the paper will contain articles written by some "high brow" who, in terms which are Latin and Greek to him, will inform him that he is a "rough neck" or a "hill billy" and that what he thinks he knows is a delusion and that science and textbook learning can prove that black is a shade of white by another name and he is afraid that some of his friends will read both articles and tease him about it. If he conceives the idea of benefiting his fellow craftsmen by relating his experience he is liable, too, to forsake the idea owing to an attack of "editor shakes." To one who has never screwed up the required nerve to approach an editor the first effort usually causes dreams at night of said party wearing horns and handing back papers with sarcasm. Those of the craft who are in the habit of overflowing should dispel this by splashing and yelling, "The water's fine!"

The fact that a practical man lacks the ability to write in technical language or to describe conditions fully in technical terms should not keep him from coming in on any discussion as, after all, it is the "proof of the pudding" which is of most value to us all, and if he does not sometimes differ with the textbooks there must be something wrong with him.

For instance, it may be gathered that water-tube boilers are preferable to flue boilers for any installation. Are they? He might also read that the spring pop-safety valve is always better than the old reliable, easily understood, easily adjusted lever. Is it? He might also get the impression that any expenditure for equipment would be justified if economy in operation were secured, regardless of conditions and size of installation. Would it? He might also, for another instance, find good authorities giving as efficient belt speeds anything between 3500 and 5000 feet per minute, most of them under 5000, and yet all of the big engines he knows of may be running the flywheel rim at a speed of a mile a minute. He may probably have read lately where an eminent authority stated that 11,290 feet per minute belt speed was common in Europe, becoming very popular in America and had exhibited the greatest economy.

In all of the printed matter on power transmission he has at hand he may not find one case where the author states whether his figures are based on a straight, cross or quarter-turn belt; what the size of the belt is, distance between centers, or whether an idler is used or not; whereas he may have an overloaded belt in his plant running under an idler and breaking pulley after pulley without perceptible slippage or any noticeable injury to the belt and a statement of the facts would bring him a satisfactory solution from two dozen readers.

This last is not imaginary. I had a chance once to help a fellow out who had brought about that condition by reducing the belt speed, still transmitting the same quantity of power. He thought that the pulleys were defective.

In the little things, at least—these are all that I am competent to speak about—I know that the words of the "old boys," who have had to wiggle out of their own difficulties, are the most valuable that we can read.

W. R. SMITH.

Alton, Ill.

Chimney Problem

In regard to L. G. Watry's "Chimney Problem" in the December 27 issue, I do not think that the stack with the larger opening would draw cold air down the other one, for the reason that the area of both stacks combined is a little on the small side of the right area to give good results for two 50-horsepower boilers. A stack 22 inches square should be at least 50 feet high to give good results for one 50-horsepower boiler. So, with two boilers and two 22-inch stacks the hot gases would certainly fill both and rise to the top.

In Mr. Watry's case I think it would be better to divide the smoke box, making separate stacks for each boiler, and have the flues and openings slightly larger than the area of the stack so as not to retard the draft. Better results could be had if the stacks could have at least 10 feet more added to make their hight not less than 50 feet.

GEORGE H. HANDLEY.

Newburgh, N. Y.

Burning No. 3 Buckwheat Coal

In the issue of December 27, 1910, Warren O. Rogers, as a result of a visit to the New York Steam Company's plants in New York City, furnishes a description of his visit with some very positive conclusions.

It is with considerable regret that I note Mr. Rogers' visit was entirely confined to the plants above stated, because by no means are his conclusions either accurate or confined to facts.

Wherein does Mr. Rogers err in his conclusions? He errs in the fact that he visits a plant to see something with which he is unacquainted and as a result of his observations in that one plant sets out a set of rules as being the only possible means of burning No. 3 buckwheat coal. If Mr. Rogers had visited the Brooklyn Bridge power house, located in Brooklyn, he would have found that they have been burning at that plant No. 3 buckwheat coal for several years back in place of lump coal which they were previously using, and he would have formed some radically different conclusions from those reached after his inspection.

In addition to the Brooklyn Bridge power house a list of over 100 plants in the city of New York could be furnished, all of which would give him some different ideas in regard to the conclusions which he would put forward as the only means of burning No. 3 buckwheat coal. The rules that he supplies are:

1. "Fire light and often."
2. "Keep a forced draft of from 0.5 to 0.6 inch."
3. "Keep the damper 5/16 open."
4. "Never use a slicing bar."
5. "Level the fires about every two hours or when necessary."
6. "Never throw green fuel on other than incandescent fuel."
7. "When cleaning fires, keep 1 inch of ash on the grates."
8. "Always use a shaking grate."
9. "Never handle the fire as other fuels are handled."

The conclusion is that "A small steam plant with one or two boilers would have trouble in running on this grade of fuel, because it would be difficult to force the fires in case a sudden demand was made for steam."

Commenting upon the foregoing:

No. 1. This rule is imperative.

No. 2. A forced draft must be used but it may be anywhere from 0.5 to 1½ inches, according to the fuel burned per square foot of grate surface, which may be anywhere from 12 pounds (as cited in Mr. Rogers' article as the amount burned at the New York Steam Company's plant) up to 28 or 30 pounds, which is the practice maintained in some of the plants which would be on the list I have previously referred to as being able to furnish. This rule, therefore, should be changed to read: "Use forced draft with such pressure as may be required to burn the amount of fuel necessary."

No. 3. The opening of the damper would be governed entirely by natural-draft conditions of the plant; if natural draft was poor the damper might be entirely open; if the draft was excellent then the damper should be choked down to a point so that no excess of air may be drawn in above the fire.

No. 4. It is good policy not to use a slicing bar on any grade of fuel, but if a clinker formation is prevalent it may be necessary to use a slicing bar to raise the fuel from the grate in order that the air may work through it, but a slicing bar should not be used to break through the fire and elevate the ash on top of the live fuel.

No. 5. The leveling of the fires should be done as often as required and is not governed by any specific time. There are fuels which can be leveled successfully at least twice between each time of firing; this would apply to fuel which is very hard in its character and slow burning.

No. 6. This rule can stand as given.

No. 7. If shaking grates are used, the 1 inch of ash might be of benefit to prevent loss of fuel through the grate bars, but there is no reason to keep ash on the grate for any other purpose than to prevent the coal falling through the grate openings; and if this is the condition, then the grate in use is not a proper one for the burning of No. 3 buckwheat coal as the openings in any grate used for this class of fuel should be small enough to practically prevent the fuel from falling through it. A much hotter fire will be established if the 1 inch of ash is cleaned out and the fresh fuel brought over on the grate.

No. 8. A shaking grate is not necessary; in fact, it is a positive detriment unless arrangements are made for disposal of the ash without opening the ashpit doors, and the larger percentage of power plants have no means of cleaning the ashpits except by hand tools. There is no positive rule as to whether a shaking or stationary grate shall be used to burn No. 3 buckwheat coal. The only feature about the grate is that it should have small openings in it which can retain the coal without the coal working through it in any perceptible percentage.

As to whether a shaking or stationary grate should be used, it depends entirely on the method of disposing of the ash; if a tunnel exists by which the ash can be withdrawn from the ashpit through a hopper bottom, a shaking grate is preferable, but if the ashpits must be cleaned by shoveling out (as the vast majority are cleaned), then a shaking grate is of no advantage as the cleaning can be done more readily from a stationary grate, through the firing doors. Particularly is this true as forced draft must be used in burning No. 3 buckwheat coal and the disturbing of ashpit doors for cleaning simply destroys the use of the forced draft as long as the cleaning is in process.

No. 9. This rule is not at all necessary as it will be found that No. 2 or No. 1 buckwheat or even pea coal will give better results in firing if the fuel is placed uniformly over the grate and not piled in any considerable quantity at any one point. It is furthermore unnecessary to put green fuel on the spots of fire where the fuel has not already become ignited.

Regarding the conclusions, No. 3 buckwheat coal is in successful use in a very large number of plants in New York City as well as other places where they have but one or two boilers. If a proper forced draft is in use, it is an easy matter to overrate the boiler to cover any extra demands for steam, provided the boiler is properly cared for. In a plant with one boiler where they are using No. 3 buckwheat coal if a proper forced draft is in use a fire can be run from six to eight hours, using a fair grade of No. 3 buckwheat coal, prior to cleaning, and with a little head work a time of cleaning can be established where cleaning can be accomplished without detrimental loss of steam, especially so if the furnace and its equipment have been properly designed together with the forced-draft equipment so that cleaning can be accomplished quickly and thoroughly.

Other features of the use of No. 3 buckwheat coal with which the ordinary engineer will come in contact are that there are fuels of this size placed on the market which are so hard that they do not burn freely enough to be a satisfactory steam coal, in which event a small percentage of soft coal added to them will be found beneficial. On the other hand, there are fuels of this size sold which burn out too quickly to be a satisfactory fuel, as their excessive amount of ash will prove a hardship as to disposal.

It will be well, therefore, for anyone contemplating using No. 3 buckwheat coal because of its attractiveness in price, to carefully study the supply of coal offered, and, before jumping at conclusions, investigate the subject broadly so that when he purchases equipment he will be in possession of something of a permanent value and properly studied to give him the best service.

CHARLES H. PARSON.

New York City.

A few small bolts were handed to the writer, with the request that they be charged with electricity to prevent the nuts from coming off. Further questioning proved that my predecessor had simply immersed them in the sal-ammoniac solution of the battery, which caused them to rust fast.

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Contents

PAGE

A 120,000 Horsepower Plant in France.. 178
Vacuum for Reciprocating Engines..... 182
An Efficient Boiler Installation..... 183
Expansions in Compound Engine..... 185
Confessions of an Engineer..... 186
Low Pressure Refrigerating System..... 188
Exhaust Steam in Low Pressure Turbine 188
The Straight Flow Steam Engine..... 189
Catechism of Electricity..... 193
A New Method of Setting Brushes Accurately 194
Mr. Greer's Rotary Converter Trouble... 194
The Light That Failed..... 195
Some Simple Handy Tools..... 196
Pertinent Features Relating to Gas Power 196
Some Ignition Pointers..... 198
A New Aëroplane Engine..... 198
Practical Letters:
Water Control Valve on Heater.... Estimating Refrigerating Surface ....Repairing a Pump Valve Deck ....Topics for Discussion....Heating and Piping Arrangement.... Homemade Trap....Valves in Steam Pipes....An Ice Cubing Machine .... Saved Water from Heating System 199-201
Discussion Letters:
Beading Boiler Flues....Compound Engine Proportions....Problem in Expansion of Steam....Power Plant Design and the Operating Engineer ....Introducing Solvents into Boilers....Boiler Efficiency....Does the Crosshead Stop?....Why Engineers Do Not Write....Chimney Problem....Burning No. 3 Buckwheat Coal 202-206
Editorials 207-208
Two Peculiar Flywheel Explosions..... 210
Award of Perkin Medal to Charles M. Hall 211

POWER

Precautions against Damage from Bursting Tubes

Much is written from time to time about the numerous failures of tubes in water-tube boilers, and recommendations are made that better workmanship and better material be used, and that manufacturers be compelled to stamp each tube with their name, so that responsibility for disaster may be properly fixed. All these recommendations are necessary and good, but in the meantime let us do what we can to protect the personnel in the boiler room and, until a perfect tube is found, let us fit all boiler furnaces with in-swinging doors. With all the doors in a setting of this type there is but one door opening outward—that leading into the smokestack, through which steam and hot water are discharged in the event of the rupture of a tube. In such a furnace, when a tube lets go, all the doors in the setting, if they happen to be open, are closed by the rush of the steam, or if closed they tend to stay closed tighter. This prevents any scalding of the attendants in the boiler room, and the steam and hot water are passed harmlessly up the smokestack, unless it blows down the setting, but this contingency is nothing against the use of the in-swinging doors because all that needs to be done is to make the setting stronger.

Many of the furnaces in continental Europe in many countries by governmental requirement are so equipped. In our own navy in-swinging doors have been fitted to all the battleships and their use is gradually spreading to other naval vessels.

Closely allied with the in-swinging doors to the furnace is the use of check valves in the steam lines. We firmly believe the day is close at hand when a steam line without a check valve close to the boiler will be as rare as a feed line at the present time without its check valve. The use of check valves tends greatly to reduce the damage as a result of the rupture of a tube or of the steam pipe, inasmuch as the valve itself operates either way. If a steam pipe breaks, it shuts off the steam to prevent the boilers from emptying themselves through that break. If a tube in a boiler lets go, it prevents the other boilers connected to the same header from emptying themselves through the rupture of the tube.

It is bad to have to shovel coal all day in a hot fire room; it is worse to get only two dollars a day for doing it, but it is worse still to be in constant danger of being scalded when that is not necessary.

Flywheel Explosions

There was a time when the dangers of generating and producing power from steam were confined to the boiler room. Occasionally a flywheel exploded, but steam-plant accidents were, as a rule, in the boiler room.

When engines were made larger, more powerful and designed to run at higher speeds, the engine room took on an added element of danger. Under the old practice the rim speed of the flywheel was so far below the safe speed limit that in case anything did happen to the governor, the engineer had a chance to shut down the engine before an accident occurred.

Nowadays conditions are vastly different, because most flywheels are run with a rim speed very close to the safe limit, and a slight increase in the speed of the engine brings the rim speed up to the bursting point.

Sometimes the cause of a flywheel explosion is easily discovered, but usually it is a difficult matter to determine.

Neglect on the part of the engineer is frequently responsible for such accidents, and usually consists of failure to properly adjust this or that thing on the valve or governor gear. Sometimes this is due to ignorance of the danger incurred by not taking the necessary precautions, but more often it is simple neglect to make a thing right that is known to be wrong.

Some engineers make a practice of examining the governor gear once a day, besides making a hammer test and inspection of the flywheel as well. To some this may seem "fussy," but it is better to err on the side of safety.

It is true that an engineer might inspect his engine every day for years and never find an adjustment out of its proper position; on the other hand, if the governor were found to be deranged, the safety cams so placed as to be useless, or a cracked flywheel discovered, the time that had been spent in these daily examinations would be a profitable investment.

An investigation would undoubtedly show that thousands of flywheels are seldom examined, the engineer trusting to chance that no crack has developed since

the last hasty look, and in all probability would disclose hundreds of engineers who seldom test their engine safety cams in order to determine positively that they will prevent the steam valves from opening in case the governor drops to its lowest position. If governor inspection is a part of the work you have been neglecting, see to it; do not wait until tomorrow, but test it out today and see if the safety cams will work. Then complete the work by giving the flywheel a thorough inspection.

Two Diagrams

Two indicator diagrams alleged to have been taken from the same engine within the space of a few hours show a marked difference in outline and area. One is the conventional Corliss engine type of diagram with a compression line rising to about two-thirds of the initial pressure and there meeting a vertical induction line showing a lead of the steam valve which gives full initial pressure on the piston at the very beginning of the stroke. The cutoff, expansion line and exhaust opening appear to be in accord with good practice. On the other diagram the compression does not rise higher than the terminal pressure. The admission line slants inward so much that it is clear that full pressure is not realized until the piston is well started on its way; the point of cutoff and the expansion are the same as in the other, but the exhaust does not open until the piston has reached the end of the stroke. All of the valve events except cutoff are late, as though the eccentric had been turned backward several degrees.

There is a noticeable difference in the areas of the diagrams, the one with low compression and late admission being appreciably smaller than the other. It is said, however, by the engineer who took the diagrams that the load in both instances was identical and he is asking why, with an apparent maladjustment of the valves, the engine requires less steam and consequently less fuel for a given load than when the valves are properly set.

There is no reason to doubt the sincerity of the man who furnished the diagrams, and there is no attempt on his part to deceive anyone. But has he deceived himself? Can an engine showing a certain indicated horsepower in the cylinder deliver a greater brake horsepower than when showing a greater indicated output? Does it or can it ever happen as this engineer says it does with him? Is compression to any degree economical or otherwise? The clearance space must be filled with steam at or near initial pressure before the piston starts and this steam must give up some of its heat to the cylinder and piston before it can do other work.

What is the source of supply from which this steam can be most cheaply obtained? It is heat and pressure that are wanted. Can these be furnished at a lower cost by the engine or by the boiler? Is it cheaper to fill the clearance directly from the boiler than it is to use the engine part of the time as a compressor taking energy from the flywheel in one stroke and putting it back in the next?

These questions can be answered from the mechanical laboratories of half a hundred colleges and schools in this country. They have been answered by Professor Dwelshauvers-Dery, from the school at Liège, Belgium. But the correctness of the answers has been questioned. Experiments made thus far do not prove conclusively the truth or untruth of the contention. Academic discussion which starts nowhere, applying laws which do not apply, assuming conditions which do not exist and drawing conclusions from false premises ends nowhere and is not conclusive or even enlightening. What is the real answer, and why does not some college laboratory find and announce it?

Engineer or Laborer

In the "Want Columns" of a daily paper there recently appeared the following advertisement:

> "Applications will be received from 9 to 12 o'clock, noon, Tuesday, December 27, 1910, for the position of night engineer for municipal electric-light plant. Duties to commence January 2, 1911. Engineer will be required to do his own firing, salary $60 to $65 per month. Applicants to have necessary qualifications; state age, if married or single, and enclose copies of testimonials."

This advertisement modestly announces an opportunity for a man to act as night engineer and fireman, seven nights a week, for $60 a month; $720 a year, or $1.97 a night of twelve hours' run. It also implies that there will be more than one reply and that the engineer possessing the best qualifications will secure the place—and, worst of all, there *will be* several applications for the vacancy.

Anyone with sufficient intelligence to shovel the coal necessary to keep up the steam pressure would earn all that it is proposed to pay a man for not only firing the boiler, but attending to the engine and generator as well.

The necessary qualifications are, of course, that the night engineer shall have a knowledge of the steam boiler, how to fire and care for it, know something about a boiler-feed pump and injector, steam gage, safety valve, piping and the danger to be avoided in operating a steam boiler.

The successful applicant for this remunerative position must also know about engines and generators, switchboards and a hundred and one other things that are necessary to know before a man can safely operate even a small electric-light plant.

A town treasurer when assuming office is obliged to give bonds, and nobody would think of permitting him to handle the funds of the town without such a safeguard against loss, and yet probably not one word of objection will be raised against placing the machinery in this electric-light plant, costing thousands of dollars, in the care of a man who is capable of demanding a wage of but $1.97 per day.

In all probability those having the authority to hire a night engineer have not given much thought to his competency, and perhaps do not know that the man who obtains the night job can more than save the amount that is offered per month—if he knows how; but a $1.97 a day man will not cut much of a swath in that direction.

Another thing that apparently has not been considered is that in one night the $1.97 man is liable to do more damage to the machinery in the plant than can be repaired with the entire amount paid him for a year's wage.

It does not take much of a mistake to cause several hundred dollars damage; it has been done by merely carrying the water too high in the boiler to allow a longer time to sit down before attending to the feed apparatus, with the result that a cylinder head has been blown out, causing a shutdown and a lot of dissatisfied customers. Doubtless the $60 a month man will be able to make the wheels go around, but that is not economical engineering. A real engineer is needed and cannot be hired at a rate of $1.97 per night.

The same old story, only the number is ever increasing—Three boilers and a steam header exploded during the first half of January. On January 4 the new power house of the Lorain Coal and Dock Company, near Blaine, O., was badly wrecked by the explosion of a steam header. Rushville, Mo., was the scene of another boiler explosion on January 14, which killed two men. Two days later a boiler exploded at the Cleary stone quarry, Marietta, O., and as a variation from the usual a boiler on the towboat "T. N. Davis" blew up on the same date, when the boat was six miles north of Cairo, Ill., on the Ohio river. This disaster resulted in one death.

The master mechanic of a Massachusetts mill is publishing—and evidently believes—the report of a test in which he claims to have gotten an evaporation of *over sixteen pounds* of water from and at 212 per pound of combustible.

Ignorance on the part of the buyer of the good points of high-class machinery compared with the cheap and inefficient, is what keeps the cheap factory running.

Be prepared to make repairs before the breakdown occurs; after it has happened may be too late.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Dry Sheet

What part of a boiler is the dry sheet?

B. D. S.

It is the extension in front of the tube sheet of a horizontal tubular which forms what is often called the smoke box.

Safe Stress on Stays

What is the safe stress on a boiler stay, and how is the stress calculated?

B. S. S.

The Massachusetts Board of Boiler Rules specifies a maximum working stress of from 6000 to 9000 pounds per square inch of minimum cross-sectional area, depending on material, construction and size. The stress on a stay is the number of square inches supported by the stay multiplied by the pressure per square inch, less the minimum cross-sectional area of the stay itself.

Valve Setting

How shall I set the valves of a 16x30-inch Corliss engine to get a diagram such as the POWER blueprint calls correct?

C. V. S.

With the wristplate in the middle of its travel, give the steam valves 5/16-inch lap and the exhaust valves 1/32-inch lead; that is, instead of having lap the valve will be open 1/32 inch. With the engine on the center, give the steam valves 1/32 lead.

Using Steam Expansively

What is meant by the term using steam expansively in a steam engine?

U. S. E.

When steam is admitted to the cylinder for a portion of the stroke and then cut off. The steam in the cylinder after cut-off still has pressure and expands, furnishing the energy to complete the stroke.

Horsepower of Engine

What is the horsepower of an engine 16x20 inches making 120 revolutions per minute with a mean effective pressure of 45 pounds?

H. P. E.

The horsepower of an engine is expressed by the formula

$$\frac{PAS}{33{,}000} = horsepower$$

in which

P = Mean effective pressure;

A = Area of the piston in square inches;

S = Speed of piston travel in feet per minute.

The mean effective pressure is 45 pounds per square inch. The area of the piston, neglecting one-half the area of the rod, is 201 square inches. The piston speed is 400 feet per minute. Substituting these values in the equation, it reads

$$\frac{45 \times 201 \times 400}{33{,}000} = 109.6 \text{ } horsepower$$

Strength of Boiler Seam

How is the strength of a boiler seam found?

S. B. S.

The strength of a boiler seam is the strength of its weakest part. This may be either in the sheet or in the rivets. The strength of the sheet is proportional to the length of the seam less the diameter of the rivet holes in the outer row. The strength of the rivets is the resistance they offer to shearing. The strength of the sheet is found by subtracting the diameter of the rivet hole from the pitch and dividing the remainder by the pitch. The quotient is the efficiency of the plate at the joint. The strength of the rivets is the shearing strength of one rivet multiplied by the number of rivets in a given section. The strength of the weaker of these two is the strength of the seam.

Pumping Hot Water

Why will a pump not lift hot water?

P. H. W.

Because the water which a pump handles is forced to it by the pressure of the atmosphere on the surface of the water outside of the suction pipe as fast as the pump removes the pressure from the water inside the pipe. When the water is hot the reduction of pressure inside the pipe lowers the boiling point of the water and instead of rising to the pump it gives off steam which the pump cannot remove fast enough to reduce the pressure to a point where it will rise to the pump cylinder.

Opening of Throttle Valve

Should the throttle valve of an engine be wholly or only partially open when running?

O. T. V.

The valve should be opened wide but not "jammed." As little obstruction as possible should be offered to the flow of steam from the boiler to the engine and a partially opened throttle is an obstruction.

Sluggish Gage Glass

What would cause the water to rise slowly in a gage glass immediately after it had been blown out?

S. G. G.

A partially stopped pipe or a valve not fully opened.

Pressure on Crank Pin

What would be the pressure on the crank pin of a 16x20-inch engine with 120 pounds steam pressure in the cylinder?

P. C. P.

The area of a 16-inch piston is 201 square inches and the total pressure on the pin with the crank on the center will be

$$201 \times 120 = 24{,}120 \text{ } pounds.$$

Counterbore

What is the counterbore in a cylinder, and what is it for?

E. C. C.

It is that portion of the cylinder which is bored slightly larger than the portion through which the piston sweeps. It furnishes an edge over which the edge of the piston ring travels, thus preventing the formation of a shoulder at the end of the piston travel.

Relation of Pump to Heater

What is the difference in the location of open and closed feed-water heaters in regard to the pump?

L. P. H.

The pump is between the boiler and the open heater, but the closed heater is usually between the boiler and the pump.

Two Peculiar Flywheel Explosions

Two flywheel accidents occurred recently, the first on Monday morning, January 9, at the B. C. and R. Knight textile mills No. 3, Manchaug, Mass. The flywheel was entirely demolished and the engine badly wrenched. This accident was due indirectly to a fire, as water used in putting it out soaked a belt, which later parted and allowed two waterwheels to run away with the engine.

The power plant consisted of two Corliss engines and two waterwheels. Both waterwheels were set in a basement room under the mill and back of the engine room. One of the engines was run on high-pressure steam and was set at one side of the engine room, with the flywheel next to the mill. The other engine was located on the opposite side of the engine room, with the flywheel set away from the mill; this second engine was run as the low-pressure side of the other engine, but was placed some 25 feet distant. Each engine was controlled by a separate governor and the only connection between them was the 8-inch steam pipe extending from the high- to the low-pressure cylinder. Fig. 1 gives an idea of the general layout of the power plant.

One of these flywheels was wrecked by two waterwheels running away with an engine connected to the same shaft. The other flywheel was crushed in by a driving belt which was cut by the bursting of an 11 foot line-shaft pulley, the belt wedging between the engine flywheel and the cement floor.

It seems that neither of the waterwheels was equipped with a governor, and the low-pressure engine was not equipped with a speed-limit safety stop. Although the high-pressure engine was protected by such a device, it had no control over the low-pressure engine.

About 8 o'clock on Monday morning, a fire occurred in the mule room of the factory, but was quickly extinguished by water from the company's fire hose. Water, however, saturated a belt that ran from a pulley on a shaft that was connected to the waterwheels. This shaft also supported a driven pulley on which the main driving belt from the engine ran. About half an hour after the fire had been put out, the water-soaked belt parted, relieving the two waterwheels and the low-pressure engine of all load, and, there being no governing apparatus on the waterwheels, they ran away with the engine, the speed becoming so great that the 26-foot flywheel, having a 36-inch face and weighing about 25 tons, burst into dozens of pieces.

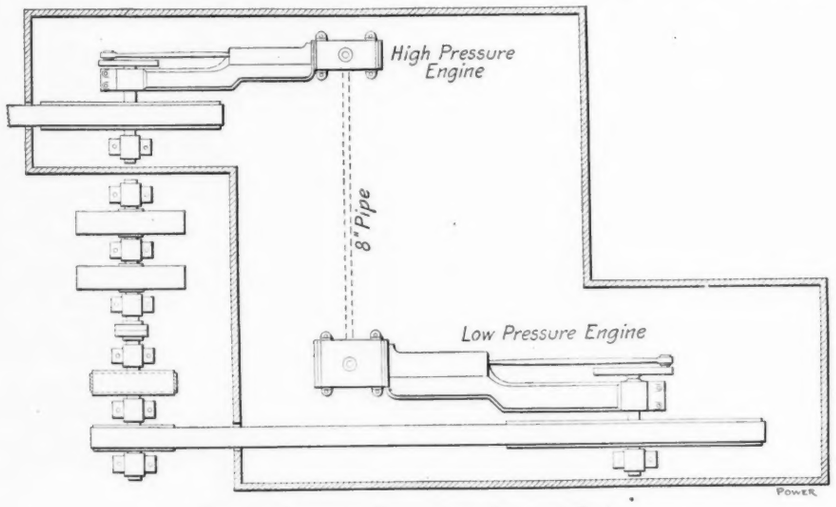


FIG. 1. GENERAL LAYOUT OF ENGINE ROOM

Some of the parts passed up through the engine-room roof, some through the rear wall and others into the wheel pit and back into the mill basement through a thick stone wall, wrecking piping, pulleys and shafting which were connected to the waterwheels.

As the engineer noted the increase of speed, an attempt was made to shut down the high-pressure engine and thus cut off the steam supply to the low-pressure engine, but before this could be done, the crash came. Fortunately, no one was killed, or seriously injured. Beside wrecking the flywheel, the main pillow block was broken at the jaws and the outer pillow block wrenched out of place. The engine will require extensive repair before it will be fit to run again.

No photographs were obtainable as the wreckage had been cleared away before a POWER representative could get on the field.

The second accident occurred at 1:30 p.m. on Wednesday, January 11, when a flywheel was wrecked at the works of the American Axe and Tool Company, East Douglas, Mass., which is but a few miles distant from Manchaug.

A line shaft on which was mounted an 11-foot pulley was belted to a 310-horsepower compound single-acting Westinghouse engine by a 19-inch belt. The flywheel on the engine was 7 feet in diameter and had a 21-inch face. The belt was given a large arc of contact on both of these pulleys, by means of two idlers which were placed as shown in Fig. 2. The 11-foot pulley was made with a cast-iron hub and spokes and a steel rim made in two sections and riveted to the spokes. The idler next to the line

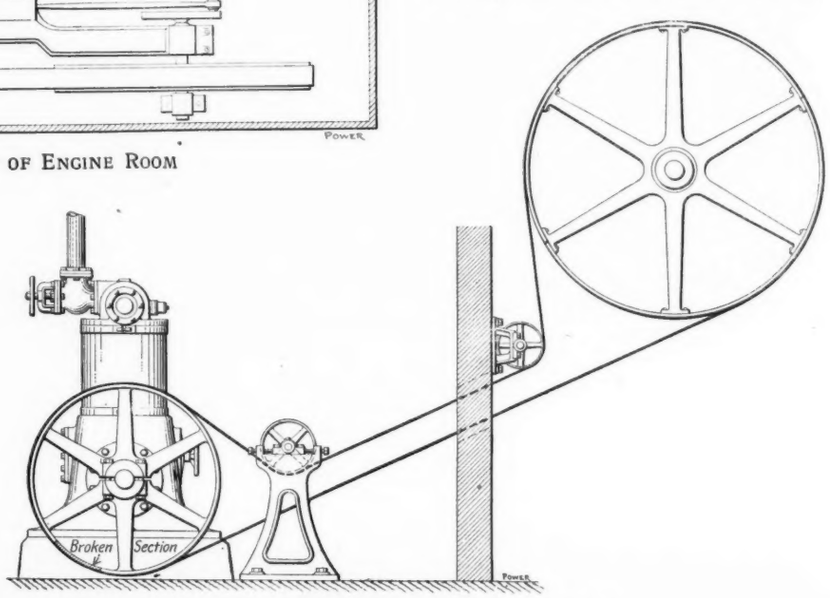


FIG. 2. ARRANGEMENT OF BELT AND PULLEYS

shaft was attached to the wall forming a partition between the engine and forge rooms. The other idler was supported by a stand placed back of the engine flywheel, and the top side of the belt was made to travel between the two idlers, a distance of one foot from the bottom, or tight side, of the belt.

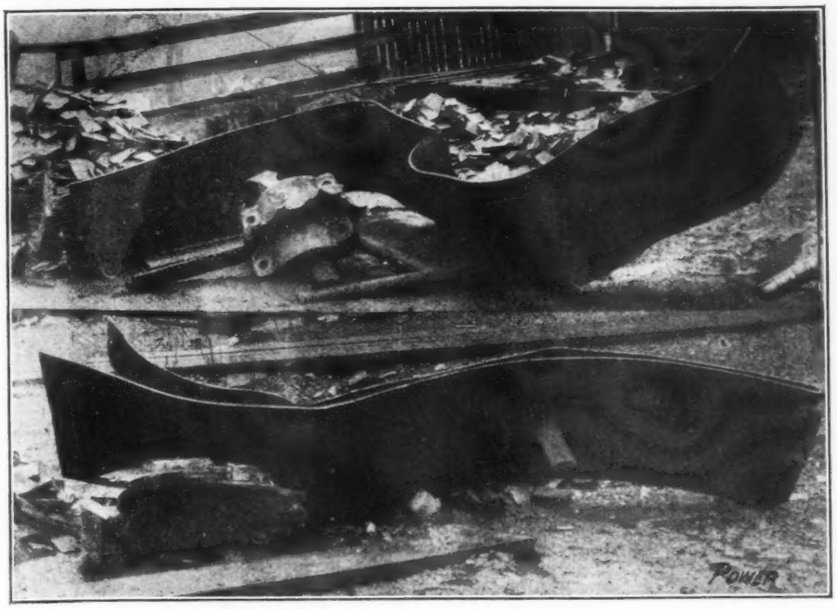


FIG. 3. TWO VIEWS OF THE STEEL RIM

This accident was doubtless due to a weakness in the 11-foot driven pulley. The initial rupture started at one of the joints of the rim where it was riveted to the spoke. As the rupture of this wheel was not instantaneous, warning was given to the men employed in the vicinity who got to a safe place before the rim parted from the spokes.

Fig. 3 shows two views of the rim section and portions of the hub and spokes. One-half of the rim was bent double at a point near the center, the face of the rim being on the inside. The other half of the rim was bent into an ogee shape.

When the pulley burst, the 19-inch driving belt was torn in two and, owing to the large contact on the face of the flywheel, instead of coming off the pulley, was wound around the rim, which ran close to the cement floor of the engine room, and so great was the pressure of the belt on the rim of the engine flywheel at the point between the floor and the wheel that a section of the rim between the spokes, 36 inches long, was forced in toward the hub, leaving the break as shown in Fig. 4.

On the inside of the rim is a crack extending part way through the metal that was made as the fractured section of the rim was forced inward. The wheel was made with a solid rim and split hub.

Owing to the prompt action of the engineer, steam was shut off over the boilers before the engine, which was running at a speed of 151 revolutions per minute, did any material damage to itself. In fact, the shaft was not even sprung, although the concrete floor directly under the flywheel was crushed in about 1½ inches, and the anchor bolts were drawn up into the foundation ⅛ inch.

The damage was small, as it will only be necessary to replace a new pulley on the line shaft, a new flywheel on the engine and a new idler. No one was hurt and a portion of the plant will be operated by water power until repairs are completed. Photographs and data were obtainable through the courtesy of Superintendent W. J. Griffin.

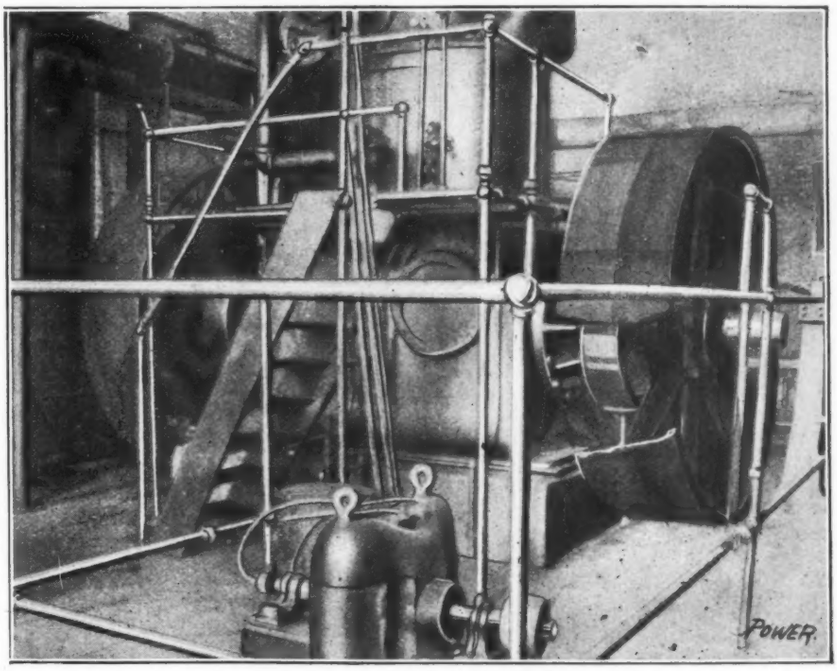


FIG. 4. FRACTURED WHEEL

Award of Perkin Medal to Charles M. Hall

The fifth annual award of the Perkin medal for important discoveries in applied chemistry took place on January 20 at the Chemists' Club in New York, when the Society of Chemical Industry presented this medal to Charles M. Hall for his achievements in the production of aluminum at low cost. The medal was first awarded (1906) to Sir William Henry Perkin for his discovery of mauve. The other medalists have been J. B. F. Herreshoff (1907), Arno Behr (1908), Edward G. Acheson (1909).

Prior to Mr. Hall's invention, aluminum had been almost a precious metal. In 1855 the metal was worth $90 per pound; in 1862 it was worth $12 per pound; in 1889 aluminum was selling at $4 per pound, this reduction having been brought about by Castner's process of producing aluminum by the use of sodium.

Hall's discovery, made in 1886, when he was but 22 years old, consisted in finding in cryolite an anhydrous solvent for alumina and then electrolyzing the alumina out of the cryolite solution. He applied for a patent in 1886, the same being granted in 1889, its validity being later passed upon by Judge William Howard Taft, now President of the United States. After experimenting with two sets of partners for several years, the work was finally taken up by the Pittsburg Reduction Company, now the Aluminum Company of America. At present this company has five establishments in the vicinity of Niagara Falls, and produces annually about 40,000,000 pounds of aluminum at a cost much below the figures given above.

ANNUAL ENTERTAINMENT AND BANQUET OF THE COMBINED CHICAGO ASSOCIATIONS OF THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS. HELD AT THE GRAND PACIFIC HOTEL, SATURDAY EVENING, JANUARY 14. A TOTAL OF 355 MEMBERS AND GUESTS WERE PRESENT AT THE BANQUET OF WHICH FRED GIELOW WAS TOASTMASTER. AMONG THE SPEAKERS WERE JOHN ERICKSON, FORMER CITY ENGINEER, SAMUEL FORSE, OF PITTSBURG, NATIONAL TREASURER OF THE NATIONAL ASSOCIATION OF STATIONARY ENGINEERS, AND JOHN LANE, EDITOR OF THE "NATIONAL ENGINEER." A PLEASING FEATURE OF THE OCCASION WAS THE ENTERTAINMENT BY BILLY MURRAY AND JACK ARMOUR, OF NEW YORK. MANY GUESTS WERE PRESENT FROM MILWAUKEE AND OTHER SURROUNDING CITIES

St. Louis Convention of Marine Engineers

The National Marine Engineers' Beneficial Association made a departure from its usual custom by holding its thirty-sixth annual convention at St. Louis instead of at Washington, where its meetings have been held for eighteen out of thirty-six years. About one hundred delegates were in attendance, representing associations from Seattle, Wash., to Portland, Me., and from the Lakes to the Gulf. The convention was called to order at the Planters hotel, by National President William F. Yates on Monday, January 16, and continued in session throughout the week.

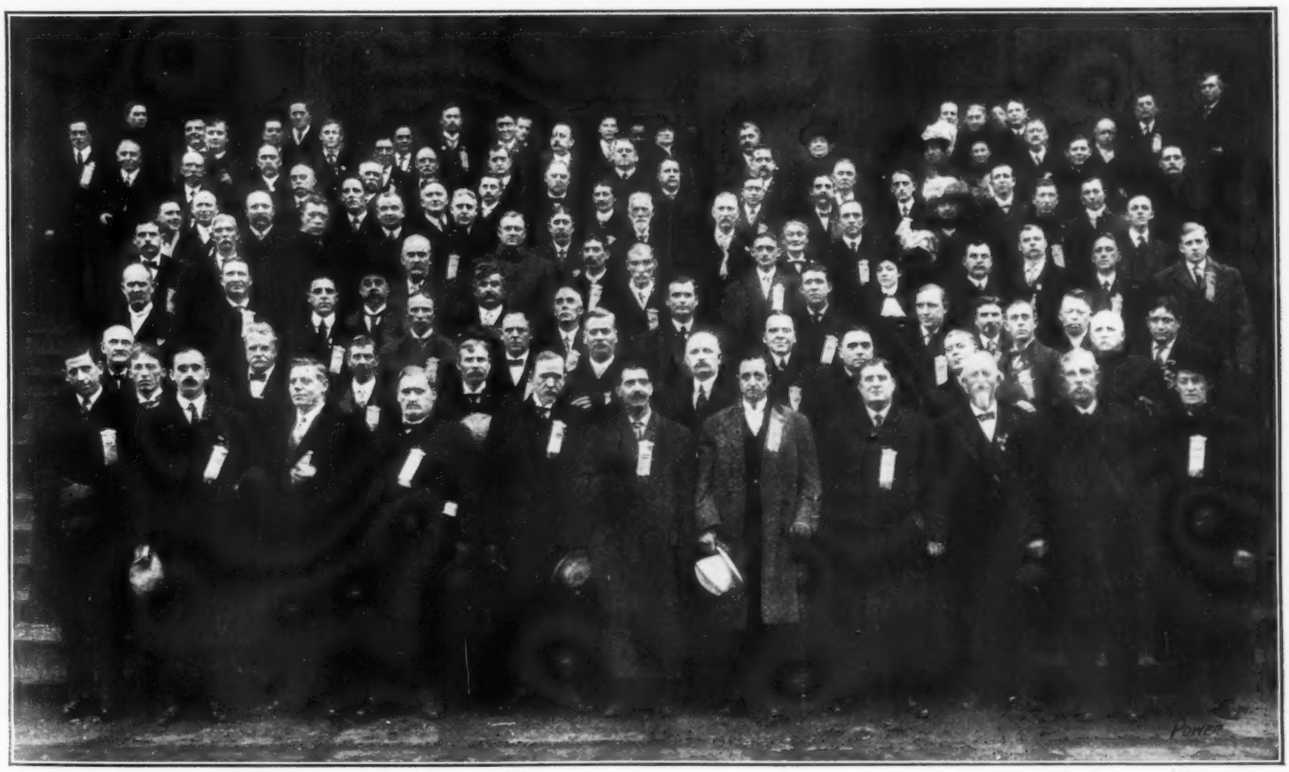
SUPPLYMEN AT ST. LOUIS CONVENTION

The balloting for national officers resulted as follows in the reëlection of the entire board, except the second vice-president: William F. Yates, president; Art. Hyde, first vice-president; George H. Bowen, second vice-president; Charles N. Vosburg, third vice-president; George A. Grubb, secretary, and Albert L. Jones, treasurer.

The social features of the convention consisted of theater parties, automobile rides, visits to the local plants, including an inspection of the Anheuser-Busch brewery, and the usual smoker, to which some four hundred of the prominent engineers of St. Louis and vicinity accepted invitations.

The supplymens' association connected with this convention chose the following officers: Frank Martin, president; F. E. Ransley, vice-president; C. A. Wilhoft, secretary.

The next annual meeting will be held at Detroit during January next.



DELEGATES AND VISITORS AT MARINE ENGINEERS' CONVENTION IN ST. LOUIS

SOCIETY NOTES

The third annual entertainment and reception of the Combined Associations of Engineers of the Borough of Brooklyn was held at Kismet Temple, Brooklyn, N. Y., on the evening of January 21. After a very interesting vaudeville entertainment, dancing was indulged in for several hours. The affair was the most successful ever held by the combined associations. The large auditorium with its several galleries was filled to overflowing by a representative gathering of engineers.

The National Electric Light Association has voted to hold the next annual convention in New York City during the week May 29 to June 3, with four days of business sessions. The meetings will be held in the United Engineering building at 29 West Thirty-ninth street, where the offices of the association are located. No hotel has been selected for headquarters but a hotel committee has been formed with Frank W. Smith as chair-

man, which this year will undertake to make definite reservations. The manufacturing members of the association, in view of the fact that there is another electrical show in New York in October, have voted to dispense this year with the collective exhibit.

BOOKS RECEIVED

THE SCIENTIFIC AMERICAN CYCLOPEDIA OF FORMULAS. By Albert A. Hopkins. Munn & Co., New York. Cloth; 1077 pages, 5¾x8½ inches; 200 illustrations. Price, $5.

HYDRAULIC TURBINES. By V. Gelpke and A. H. Van Cleve. McGraw-Hill Book Company, New York. Cloth; 293 pages, 6¾x9 inches; 200 illustrations; plates; tables; indexed. Price, $4.

ELECTRICIANS' OPERATING AND TESTING MANUAL. By Henry C. Horstmann and Victor H. Toulsey. F. J. Drake & Co., Chicago, Ill. Leather; 359 pages, 4¼x6½ inches; 211 illustrations; indexed. Price, $1.50.

Water Power in New Zealand

It is reported that the New Zealand government has already passed an appropriation of $1,250,000, which is to be followed by more grants later on, to develop several of its water-power possibilities.

The government has absolute control of all the water power. Altogether there is estimated to be 3,000,000 horsepower undeveloped and available in the islands, which are only 1000 miles long and 150 miles wide at the widest part. Owing to the land being so suitable for agriculture and to the European market being so distant, very little attention has been given to manufacturing and so heretofore the water power has not been utilized. New factories are springing up and with cheap electric power a great impetus will be given the growing industries. American manufacturers will surely do well to pay attention to this promising field.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

INTERNAL COMBUSTION ENGINE. Thaddeus W. Heermans, Chicago, Ill. 980,946.

WIND MOTOR. Alexander Norman, Dos Palos, Cal. 980,995.

TURBINE. William E. Snow, Dedham, Mass., assignor to B. F. Sturtevant Company, Boston, Mass., a Corporation of Massachusetts. 981,021.

TURBINE. Julian H. Rivers, Niotaze, Kan., assignor to Kaessmann-Rivers Development Company, St. Louis, Mo., a Corporation of Missouri. 981,311.

ENGINE. Joseph Z. Savoie, Providence, R. I. 981,316.

TWO-CYCLE INTERNAL COMBUSTION ENGINE. Donn Irving Twitchell, New York, N. Y., assignor to George H. Benjamin, New York, N. Y. 981,331.

BOILERS, FURNACES AND GAS PRODUCERS

GAS PRODUCER. George P. Davis, Detroit, Mich. 980,923.

STEAM BOILER. John E. Fernstrum, Menominee, Mich. 981,078.

STEAM GENERATING APPARATUS. Wilberforce B. Hammond, Brookline, Mass., assignor to General Fire Extinguisher Company, New York, N. Y., a Corporation of New York. 981,081.

OIL BURNER. Henry J. Hennings, San Gabriel, Cal. 981,083.

APPARATUS FOR GENERATING STEAM OR OTHER VAPORS. Edward C. Newcomb, Boston, Mass., assignor to the Newcomb Motor Company, a Corporation of New York. 981,216.

DOWNDRAFT FURNACE. William H. James, Cincinnati, Ohio. 981,275.

WATER-TUBE BOILER. James L. Butler, Akron, and Norman Slee, Barberton, Ohio, assignors to the Babcock & Wilcox Company, New York, N. Y., a Corporation of New Jersey. 981,377.

GRATE STRUCTURE. John R. Fortune and Harold S. Wells, Detroit, Mich., assignors to Murphy Iron Works, Detroit, Mich., a Corporation of Michigan. 981,408.

LIQUID FUEL BURNER. William A. Wallace and Albert Crume, Brush, Colo. 981,504.

POWER PLANT AUXILIARIES AND APPLIANCES

COUPLING PIPE. Joseph H. Glauber, Cleveland, Ohio. 980,939.

ROTARY VALVE. Brinay Smartt, Nashville, Tenn., assignor to Thomas Maddin Steger, Nashville, Tenn. 981,019.

PUMP. Frank L. Antisell, New York, N. Y., and David W. Blair, Perth Amboy, N. J. 981,518.

AUTOMATIC TIME VALVE. Frederick S. Hutchins, San Francisco, Cal., assignor of one-half to Irvin Silverberg, San Francisco, Cal. 981,271.

AUTOMATIC SAFETY VALVE FOR WATER GAGES. William H. Bray, Manchester, N. H., assignor of one-half to Hattie L. Healey (now by marriage Hattie L. Felch), Manchester, N. H. 981,370.

LUBRICATOR VALVE FOR STEAM CHESTS. Frank W. Edwards, Logansport, Ind., assignor to the Chicago Lubricator Company, Chicago, Ill., a Corporation of Illinois. 981,544.

ELECTRICAL INVENTIONS AND APPLICATIONS

ALTERNATING-CURRENT ELECTRIC MOTOR. Hans Sigismund Meyer, Bremen, Germany, assignor to General Electric Company, a Corporation of New York. 980,986.

RENEWABLE FUSE FOR ELECTRIC CIRCUITS. Joseph A. Volk, Jr., South Norwalk, Conn. 981,038.

ROTARY CONVERTER. Joseph L. Burnham, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 981,059.

AUTOMATIC ARC LAMP. Ernst Sailer, Rochester, N. Y., assignor by mesne assignments, to Bausch & Lomb Optical Company, Rochester, N. Y., a Corporation of New York. 981,121.

ROTARY CONVERTER. Charles P. Steinmetz, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 981,134.

ELECTRIC SWITCH. Philip Thos. McNally, Mandan, N. D. 981,452.

ELECTRIC HEATER. Milton H. Shoenberg, San Francisco, Cal., assignor to Presto Electrical Manufacturing Company, San Francisco, Cal., a Corporation of California. 981,481.

APPARATUS FOR MEASURING AREAS BY MEANS OF ELECTRIC RESISTANCE COILS. Julius Josef Götz, Offenbach-on-the-Main, Germany. 981,552.

RHEOSTAT. Charles D. Kestner, New York, N. Y., assignor to the Meyrowitz Manufacturing Company, a Corporation of New Jersey. 981,572.

POWER PLANT TOOLS

SCREW DRIVER. Willey B. Lane, Philadelphia, Penn., assignor of one-half to J. C. McCarty & Co., a Corporation of New York. 981,202.

WRENCH. James F. Wright, Canton, Ohio. 981,234.

WRENCH. Rudolph J. Bomblatus and Frank Caviola, Forbes Road, Penn. 981,523.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., Col. E. D. Meier; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., Dugald C. Jackson; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., Frank W. Frueauff; sec., T. C. Martin, 31 West Thirty-ninth St., New York. Next meeting in New York City, May 29 to June 3.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railroad, Cleveland, O. Next meeting to be held September, 1911, in Boston Mass.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., Carl S. Pearse, Denver, Colo.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Cincinnati, Ohio.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting at Detroit, Mich., January, 1912.

INTERNAL COMBUSTION ENGINEERS' ASSOCIATION.

Pres., Arthur J. Frith; sec., Charles Kratsch, 416 W. Indiana St., Chicago. Meetings the second Friday in each month at Fraternity Halls, Chicago.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, John Cope; sec., J. U. Bunce, Hotel Statler, Buffalo, N. Y. Next annual meeting in Philadelphia, Penn., week commencing Monday, August 7, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; acting sec., Charles P. Crowe, Ohio State University, Columbus, Ohio. Next meeting, Youngstown, Ohio, May 18 and 19, 1911.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., J. G. Hannahan, Chicago, Ill. Next meeting at St. Paul, Minn., September, 1911.

NATIONAL DISTRICT HEATING ASSOCIATION

Pres., G. W. Wright, Baltimore, Md.; sec

BUSINESS ITEMS

The American Ship Windlass Company reports recent sales of Taylor stokers to the Detroit Steel Castings Company; Peters Cartridge Company, King's Mills, Ohio; Tremont & Suffolk Mills, Lowell, Mass., and the Springfield Street Railway Company.

The Long Grate Bar Company, of Buffalo, N. Y., maker of Long's duplex-shaking grate, has arranged with the Frick Grate Bar Company, 421 Chestnut street, Philadelphia, Penn., to act as sole selling representative in the Philadelphia territory.

W. E. Van Keuren, who has been connected with the selling end of the Bundy trap business for 12 years, the last four of which were in the New York office, resigned his position on February 1 to become New York manager of the Gillette Safety Razor Company.

Bulletin No. 187, Sturtevant Engineering series, is a reprint of F. R. Low's article on "Economical Fireroom Methods," which appeared in POWER, August 2, 1910. The plant contained return-tubular boilers, which were hand fired. Fans furnished the draft and economizers were employed. Some remarkable results were obtained, and the pamphlet, which is being sent out upon request by the B. F. Sturtevant Company, Hyde Park, Mass., attributes the high efficiency to careful design of the plant and intelligent manipulation of high-grade boiler-room equipment.

The Simplex Engineering Company, 1111 Locust street, Philadelphia, Penn., makers of the Simplex pipe clamp, received a letter on January 14, from James Parry, chief engineer of Ehrich Brothers, New York, in which he says that the 7-inch Simplex pipe clamp, which he bought in December, 1908, was placed on a steam line 150 feet in length, steam being turned off at night and turned on in the morning, causing a great deal of expansion and contraction. Mr. Parry says he can highly recommend the Simplex clamp to anyone, and it can be seen in service at the present date at his plant, after having discarded several other kinds.

Sixty years in business in any line is a good record. When that length of time has been applied to the manufacture of a product which has and is meeting a decided need and is, incidentally, a success, that record becomes really enviable. William Baragwanath & Son, of Chicago, have that kind of a record. They manufacture feedwater heaters and condensers exclusively, and it is needless to say that their products have improved during this long period. Their Baragwanath barometric condenser, for instance, with the adjustable nozzle and no air-pump features, is very popular. Their steam-jacket heater, with its extra chamber created by the addition of an outside jacket, is another well-known product. And the same applies to their surface condenser, open heaters, steam and oil separators. The complete line of Baragwanath specialties are described in a catalog which they send to those interested.

NEW EQUIPMENT

Dundas, Ont., will install a new hydro-electric station.

Taunton, Mass., contemplates installing a filtering system.

Redkey, Ind., will construct an electric-light and power plant.

An electric-light plant is to be installed at New Lisbon, Wis.

New Lisbon, Wis., will establish a municipal lighting plant.

Henderson Brothers, Cambridge, Mass., will install a steam boiler.

Moncton, N. B., will spend $250,000 extending its waterworks plant.

The Easton (Md.) Light and Fuel Company will erect a new station.

Edmonston, N. B., will install a complete new electric-lighting plant.

Hoisington, Kan., has issued bonds for the construction of waterworks.

Helena, Mont., voted $65,000 bonds for municipal waterworks plant.

Britton, Okla., will construct a waterworks plant to cost $30,000.

Falls City, Ore., will install a municipal water system to cost $25,000.

Freewater, Ore., will install a municipal water system to cost $16,000.

The Crocker-Burbank Company, Fitchburg, Mass., will install a steam boiler.

J. I. Moore, of Minot, N. D., will install an electric-light plant at Stanley N. D.

Port Arthur, Ont., will make extensive improvements to its street-lighting plant.

The Empire Chair Company, Elizabethtown, Tenn., contemplates installing motors.

The Quebec Railway, Light, Heat and Power Company is building a $200,000 plant.

R. A. Brown, Gaston, Ind., is preparing to install an electric-lighting and power plant.

The Roanoke (Va.) Railway and Electric Company will install a 2000-kilowatt turbine.

The Chrisfield Light and Power Company, Bridgeville, Del., will erect a new gas plant.

The city council, Hamilton, Iowa, is considering the construction of a pumping plant.

Silverton, Ore., contemplates the installation of a municipal water and sewerage system.

The Great Northern Railroad will double the capacity of its ice plant, at Hillyard, Wash.

The Charlton Mills, Fall River, Mass., is in the market for boiler equipment for a new plant.

The Lackawanna Cold Storage Company, Scranton, Penn., will erect a seven-story plant.

The citizens of Tower, Minn., will vote on the issuance of bonds for building a power plant.

The Arctic Ice Cream Company, Detroit, Mich., will erect a creamery and cold-storage plant.

The Passaic (N. J.) Worsted Spinning Company is erecting a new factory and power plant.

The Ridgefield (Conn.) Electric Light Company will install a new electric-generating plant.

The Rhode Island Coöperative Coal Company, Providence, R. I., will install a steam boiler.

The Oriental Silk Printing Company, Haledon, N. J., will install a new engine and boiler.

The town of Marblehead, Mass., will install a 2,000,000-gallon high-duty pumping engine.

W. F. Holt, Calexico, Cal., will build a new steam plant at El Centro, Cal., to cost about $25,000.

The Buckeye Ice and Coal Company, Findley, Ohio, is contemplating the erection of an ice plant.

The International Rubber Company, West Barrington, R. I., is making additions to its power plant.

L. B. Dow, 176 Federal street, Boston, Mass., is in the market for an 11x15 center-crank engine.

The New York, New Haven & Hartford Railroad is erecting a new power house at Adams, Mass.

The Lubec Sardine Company, Belfast, Me., is considering the installation of a 60-kilowatt electric plant.

The Winnipeg (Man.) Electric Railway Company will build a $75,000 steam turbine power station.

The Bloomer (Wis.) Electric Light and Power Company, recently incorporated, will install a plant.

Louis P. Larson will erect an electric-light plant and waterworks at Metalline Falls, near Colville, Wash.

Thirteen thousand dollars will be spent on improvements at the Rushville, Ind., water and light plant.

The Duarte Mutual Irrigation Company, Monrovia, Cal., will install two high-power pumping plants.

The Salisbury (Md.) Light, Heat and Power Company intends to install new electrical equipment.

The Spokane Falls Gas Light Company, Spokane, Wash., will erect a large addition to its power plant.

A. G. Simpson, of Chico, Cal., is planning the erection of a power plant on Deer creek, near Red Bluff, Cal.

Fire destroyed the power house of the Jonathan Creek Coal Company, at Zanesville, Ohio. Loss, $15,000.

E. F. Glaze, of the Goliad (Tex.) Water and Light Company, has plans for the erection of an ice plant.

The Simpson-Crawford Company, Sixth avenue, New York, will install a complete power plant in its building.

The Kenton (Ohio) Gas and Electric Company is contemplating the erection of a new plant to cost $600,000.

The Weymouth (Mass.) Electric Light and Power Company will install a steam turbine electric-generating unit.

The Lowell Rendering Company, South Lowell, Mass., anticipates the installation of a 300-kilowatt generator.

The Whidby Island Light and Power Company, Coupeville, Wash., will erect an electric-light plant and waterworks.

The Stayton (Ore.) Electric Light Company has purchased site on the Santiam river and will build a power plant.

Benj. Douglas, Ford building, Detroit, Mich., desires estimates on steam or electrical power plant to be erected near there.

The plant of the General Electric Company, at Minneapolis, Minn., recently burned, is to be rebuilt at a cost of $750,000.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn street, Chicago.

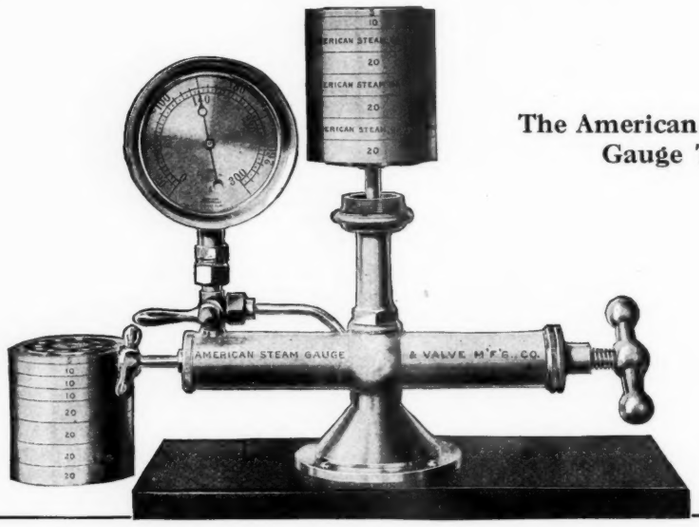
INSPECTORS WANTED—Men competent to make boiler, elevator and liability inspections; reply fully, stating experience, references, etc. Address Box 369, POWER.

WANTED—Salesmen calling on power plants where belting is used, to sell guaranteed pulley wheel facing. The Non-Slip Company, 150 A, Nassau St., New York.

SALES AGENTS to sell steam turbine blowers, feed water regulators, ventilating fans, pumps, etc.; guaranteed territory; commission. Wing, 90 West St., New York City.

WANTED—Experienced salesman to sell the Rolin patent adjustable grate bar; exclusive territory and liberal commission. Write Standard Grate Company, Heed building, Philadelphia.

WANTED—Engineering salesman; young man, technical graduate, preferred, to sell a well known line of special machinery; state preparation, experience and salary expected. Address "B. C.," Care POWER.



The American Deadweight Gauge Tester

Are You Sure That Your Gauges Are Accurate?

How do you know but what carelessness or abuse may have impaired their accuracy? How do you know whether or not you are keeping up the *right* pressure, whether the furnace is being fired correctly?

The only way to be absolutely certain that your gauges are giving you truthful figures is to test them regularly with an

American Deadweight Gauge Tester

This device tests the gauges by dead weights—it shows instantly whether they register correctly.

It's a well constructed, long lasting device that guards against fuel waste, that prevents the gauges from misleading you into *wrong* firing.

May we send you complete details of this as well as our other specialties?

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

New York, 26 Cortlandt St. **Atlanta, 525 Candler Bldg.** **Chicago, 130-132 No. Jefferson St.**
Pittsburg, Columbia Bank Bldg. **San Francisco, Monadnock Bldg.** **Montreal, 444 St. James St.**

You need not hesitate to buy your American-Thompson Indicator

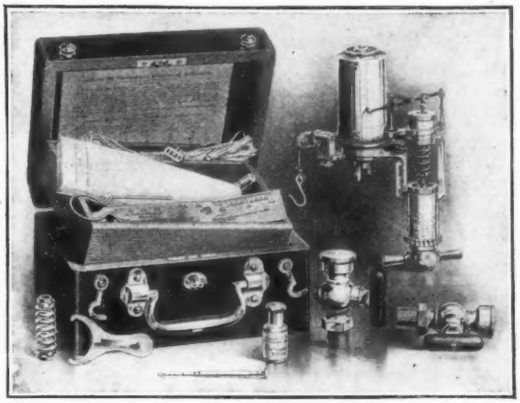
The Easy Terms Are In Your Favor

American-Thompson Indicators are sold on the installment plan simply to make it easy for engineers to buy.

But the usual installment methods do not apply.

You Secure Cash Price

For instance, you get the benefit of the Cash Price—if you were to pay cash down the price would be $55.00 just the same—the easy terms being made for *your convenience.*



Then again, we never claim a forfeit on an indicator or harass for payment—

Which means that if you are sick or disabled we are always willing to meet you half way.

Furthermore, if for sickness or other reasons you are absolutely unable to pay the installments, we will take back the indicator and refund all the money you have paid minus the cost for overhauling the instrument.

You Can't Risk Anything

You simply can't risk anything when you buy an American-Thompson—it is sold on the fairest terms you could wish.

Terms that are so easy that any engineer can own and secure the benefit of the best indicator, the recognized standard.

That's why every American-Thompson Indicator user is also a friend of ours.

Even when you send your first payment you risk nothing—we give you the privilege of examining your outfit for a period of five days, before you definitely decide to keep it.

If it isn't completely satisfactory to you—return it and your $5.00 will be refunded without question.

You have probably often wished for an American-Thompson, you ought to have one if you are ambitious to advance.

This Is Your Chance

Here's your chance to get the best indicator made, on terms as easy as those on which inferior instruments are sold.

An indicator that will give you continually accurate service. Besides, when you own an American-Thompson Indicator you'll have the satisfaction of knowing there isn't an engineer living who has a better one than yours.

You *can* afford $5.00—the indicator itself will help you pay the balance.

So don't hesitate any longer—*send the first payment today* and we will ship your American-Thompson at once.

$5.00 down—$5.00 monthly

The indicator, either exposed or inclosed spring, is shipped in a neat mahogany case. With it go two single cocks or one 3-way cock as preferred, one scale, all necessary wrenches, screw driver, bottle of porpoise oil, etc. Also a 200-page Instruction Book, which makes errors impossible, FREE.

If you want further details, sign and mail the coupon.

American Steam Gauge & Valve Mfg. Company

Boston, Mass.

New York Chicago Atlanta
Pittsburg San Francisco Los Angeles

American Steam Gauge & Valve Mfg. Co.
Boston, Mass.

Send me full details of your Indicator Offer No. 95.

Name . . . . . .

Address . . . . . .

City and State . . . . . .

HELP WANTED *(Continued)*

DRAFTSMAN WANTED—An experienced mechanical draftsman, preferably with a technical education, or a number of years' practical shop experience, by a large manufacturing concern in Massachusetts; state age, experience and salary expected by addressing Box 367, POWER.

WANTED—By a large New York electric light company, operators and dynamomen familiar with alternating- and direct-current systems; men with two and three years' experience will be accepted and advanced rapidly; state age, experience, education and salary desired. Box 364, POWER.

A YOUNG MAN to take charge of boiler houses of a large steel plant in the Chicago district; must have previous experience and good record in a similar position and must have thorough knowledge of economical production of steam; replies should state experience, references and salary expected. Address "P. L. V.," 1300 Trude Bldg., Chicago.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

ADVERTISER WISHES position in charge of plant in manufacturing establishment, or to superintend installing of machinery in new factory. Box 365, POWER.

SUPT., M.M., or chief engineer; practical and technical training, manufacturing construction, foundry, hydraulic, electric, marine, railroad and stationary engineering. Box 368, POWER.

WANTED—Position by engineer who can do things, with concern who appreciates worth and ability; unquestionable reference. H. R. Rockwell, C. E., Mt. Vernon Car Mfg., Mt. Vernon, Ill.

SITUATION WANTED in a power plant by young man with three years' steam engineering experience; hold city license; strictly sober; will go anywhere. Daniel J. Woll, Barnes, N. D.

STATIONARY ENGINEER wants position; now employed; seven years' experience with heavy duty gas engines; A-1 electrical operator; temperate, married; age 33; best references. Box 362, POWER.

CHIEF ENGINEER of considerable all-around experience, erecting and operating, medium and large steam, electric, refrigerating and waterworks plants, desires position; age 40. Box 355, POWER.

POSITION by a young man with good technical education; graduate mechanical and electrical engineer; practical experience as machinist and draftsman; best references; will go anywhere in United States; single; moderate salary to start. Box 366, POWER.

WANTED—Position as engineer by young married man, experienced in operating alternating- and direct-current generators, Corliss and automatic engines, return tubular and water tube boilers; references. Address Box 354, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

Patents. C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—Small screw cutting lathe, chuck and tools; fine condition; bargain. South Bend Machine Co., South Bend, Ind., 424 Madison St.

FOR SALE—No. 1 American Thompson indicator with reducing wheel, three springs and three-way cock. Shattuck & Simpson, 99 John St., New York.

FOR SALE—20x48 Wheelock engine and two 72"x18' high pressure tubular boilers in good condition cheap. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

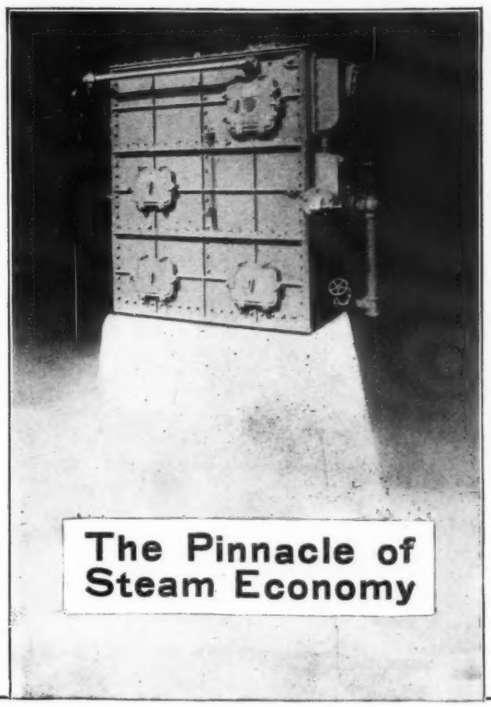
FOR SALE—One 2000-h.p. Wheeler surface condenser with vacuum and centrifugal circulating pumps. Reply to Purchasing Dept., Sulzberger & Sons Co., Chicago, Ill.

BOILERS FOR SALE—23 second hand, 100 h.p. Erie City economic boilers; in good condition; thrown out of service on account of installation of central boiler plant. For particulars address Box 370, POWER.

FOR SALE—Ideal tandem compound engine, 14"x16"x22" cylinders, direct connected to 135 kw. Fort Wayne, 220-volt, direct-current generator; delivery at once; this unit is in first class condition and as good as new. Textile Machine Works, Reading, Penn.

ALPHABETICAL INDEX *to* ADVERTISERS

	PAGE
Acheson Graphite Co., International	80
Ajax Iron Works	111
Akron Metallic Gasket Co.	85
Albany Lubricating Co.	82
Alberger Condenser Co.	99
Allan & Son, A.	114
Allis-Chalmers Co.	98
American District Steam Co.	102
American Eng. Co.	112
American Goetze-Gasket and Packing Co.	85
American Mfg. Co.	97
American Metal Hose Co.	84
American Radiator Co.	92
American Ship Windlass Co.	79
American Steam Gauge and Valve Mfg. Co.	62 and 63
Ames Iron Works	74
Anderson Co., V. D.	94
Armstrong Mfg. Co.	87
Ashcroft Mfg. Co.	91
Ashton Valve Co.	86
Austin Separator Co.	94
Babcock & Wilcox Co.	105
Baker Valve Co.	109
Ball & Wood Co.	114
Ball Engine Co.	113
Baragwanath & Son, Wm.	100
Barnes Co., W. F. & John	103
Bates Machine Co.	101
Bignall & Keeler Mfg. Co.	87
Blake & Knowles Steam Pump Works	100
Bogart Gas Power Engr. Co.	78
Bristol Co.	4th cover
Brown Engine Co., C. H.	113
Brownell Co.	114
Bruce-Macbeth Engine Co.	111
Buckeye Engine Co.	115
Builders Iron Foundry	106
Burt Mfg. Co.	18
Cameron Steam Pump Works, A. S.	98
Cancos Mfg. Co.	85
Casey-Hedges Co.	105
Cataract Refining & Mfg. Co.	80
Chapman Valve Mfg. Co.	85
Chesterton Co., A. W.	103
Cling-Surface Co.	97
Columbian Rope Co.	96
Consolidated Safety Valve Co.	91
Cooper Co., C. & G.	114
Crosby Steam Gage & Valve Co.	88
Curtis & Curtis Co.	87
Dart Mfg. Co., E. M.	87
De Laval Steam Turbine Co.	98
Dearborn Drug & Chemical Works	5
Deming Co.	99
Detroit Lubricator Co.	81
Diamond Rubber Co.	84
Dixon Crucible Co., Jos.	81
Du Bois Iron Works	110
Elliott Co.	7
Elyria Gas Power Co.	111
Engineer Co., The	90
Epping-Carpenter Co.	98
Erie Mfg. & Supply Co.	112
Eureka Packing Co.	69
Fairbanks, Morse & Co.	110
Fitchburg Steam Engine Co.	113
Foos Gas Engine Co.	111
Fort Wayne Electric Wks.	83
Foster Engineering Co.	87
Garlock Packing Co.	9
General Electric Co.	117
Goulds Mfg. Co.	98
Green Fuel Economizer Co.	79
Greene, Tweed & Co.,	84 and 4th cover
Griffith & Wedge Co.	115
Griscom-Spencer Co.	90
Hammel Oil Burner Co.	77
Hancock Inspirator Co.	91
Harbison-Walker Refractories Co.	107
Harris Steam Engine Co., W. A.	114
Harrisburg Fdry. and Mach. Works	114
Harrison Safety Boiler Wks.	65
Hawkes Boiler Co.	104
Hayden & Derby Mfg. Co.	91
Heine Safety Boiler Co.	104
Hewes & Phillips Iron Wks.	114
Hoffman, Geo. W.	77
Homestead Valve Mfg. Co.	86
Hooven, Owens, Rentschler Co.	115
Hoppes Mfg. Co.	100
Houston, Stanwood & Gamble	109
Hughson Steam Specialty Co.	88
Huyette Co., Inc., Paul B.	103
Ingersoll-Rand Co.	118
International Textbook Co.	71
Jamieson & Co., M. W.	74
Jefferson Union Co.	14
Jenkins Bros.	67
Johns-Manville Co., H. W.	74
Keeler Co., E.	105
Kellogg & Co., E. H.	74
Kellogg, M. W.	87
Kennicott Co.	103
Kerr Turbine Co.	113
Keystone Lubricating Co.	3
Kingsford Fdry. & Mach. Wks.	104
Lagonda Mfg. Co.	3d cover
Laidlaw-Dunn-Gordon Co.	77
Leddell-Bigelow Co.	110
Liberty Mfg. Co.	7
Lisk, J. P.	103
Lunkenheimer Co.	4
McClave-Brooks Co.	12
McCord Mfg. Co.	75
McGraw-Hill Book Co.	72
McIntosh, Seymour & Co.	116
McLeod & Henry Co.	106
Magnolia Metal Co.	111
Manning, Maxwell & Moore	91
Manzel Bros. Co.	80
Martin Grate Co.	78
Mason Regulator Co.	88
Monarch Valve & Mfg. Co.	88
Morehead Mfg. Co.	92
Morrin Climax Boiler Co.	105
Morse Chain Co.	96
Murphy Iron Works	78
Nagle Corliss Engine Wks.	112
National India Rubber Co.	85
National Pipe Bending Co.	101
National Tube Co.	87
Neemes Bros.	78
Nelson Valve Co.	89
New Bedford Valve Mfg. Co.	86
New Process Raw Hide Co.	96
New York & New Jersey Lubricant Co.	83
New York Belting & Packing Co., Ltd.	10
New York Edison Co.	76
Newhall Engr. Co., Geo. M.	95
Nicholson File Co.	100
Northern Equipment Co.	103
Nugget Packing Co.	84
Ohio Blower Co.	93
Ohio Brass Co.	102
Oil Well Supply Co.	105
Open Coil Heater & Purifier Co.	101
Parson Mfg. Co.	77
Patterson & Co., Frank L.	74
Peerless Rubber Mfg. Co.	8
Penberthy Injector Co.	13
Pennsylvania Flexible Metallic Tubing Co.	90
Perfection Grate Co.	78
Philadelphia Grease Mfg. Co.	80
Pierce Co., Wm. B.	2d cover
Pittsburgh Valve, Fdry. and Construction Co.	87
Powell Co., Wm.	86
Power Specialty Co.	85
Precision Instrument Co.	90
Providence Engineering Wks.	115
Reliance Gauge Column Co.	94
Rhoads & Sons, J. E.	1st cover
Richardson-Phenix Co.	81
Ridgway Dynamo and Engine Co.	112
Robb-Mumford Boiler Co.	104
Robertson & Sons, Jas. L.	73
Rollins Engine Co.	114
Saginaw Mfg. Co.	96
St. John, G. C.	103
Salamander Grate Bar Co.	78
Sargent Steam Meter Co.	109
Scaife & Sons Co., Wm. B.	77
Schaeffer & Budenberg Mfg. Co.	4th cover
Schieren Co., Chas. A.	96
Schuchardt & Schutte	108
Schutte & Koerting Co.	77
Simmons Co., John	81
Simplex Engineering Co.	87
Skinner Engine Co.	115
Smooth-On Mfg. Co.	6
Squires Co., C. E.	96
Standard Oil Co.	82
Starrett Co., L. S.	108
Steam Appliance Co., The	94
Steel Mill Packing Co.	85
Struthers-Wells Co.	111
Sturtevant Co., B. F.	109
Thermoid Rubber Co.	11
Toledo Pipe Threading Machine Co.	86
Treadwell Co., M. H.	78
Trimont Mfg. Co.	108
Tripp Metallic Packing Co.	85
Turbo-Blower Co.	77
Turner-Fricke Mfg. Co.	110
Uehling Instrument Co.	103
Under-Feed Stoker Company of America	79
Underwood & Co., H. B.	114
Union Steam Pump Co.	98
Universal Lubricator Co.	15
Vogt Machine Co., Henry	104
Von Kokeritz & Co., R. G.	84
Walton Co., F. S.	16 and 17
Washburn & Granger	78
Watson & McDaniel Co.	98
Watts-Campbell Co.	113
Westinghouse Machine Co.	112
Wheeler Mfg. Co., C. H.	99
Whitlock Coil Pipe Co.	76
Wickes Boiler Co.	104
Willcox Engineering Co.	102
Williams & Co., J. H.	108
Williams Fdry. & Mach. Co.	96
Williams Tool Co.	101
Wilson, C. E.	99
Wing Mfg. Co., L. J.	79
Worthington, Henry R.	99
Wright Mfg. Co.	94
Yale & Towne Mfg. Co.	109
York Mfg. Co.	114
Ziermore Regulator Co.	106



is reached when all of the exhaust steam is utilized in a Cochrane Heater for heating the boiler feed water, or water for other purposes. By returning to the boiler the heat contained in the steam exhausted by steam pumps, condenser auxiliaries, and stoker and fan engines, the cost of operation of these machines is reduced to practically nothing.

Preheating the feed water protects the boiler from the temperature strains that are caused by the introduction of cold feed water. Heating the water by spraying it through the steam bath of a Cochrane Heater moreover drives off air and gases, which extensive investigation has shown to be responsible for, or essential to, corrosion of the boiler and piping. If the water is fed through a closed heater, these gases are pumped through into the boiler, but if the water is heated in a Cochrane Heater they are driven out into the atmosphere.

The driving off of carbon dioxide by spraying water through the steam bath of a Cochrane Open Feed Water Heater results in the conversion of the bicarbonates of lime and magnesia into the insoluble monocarbonates, which precipitate in the heater, and therefore do not pass on into the boiler to form scale on the heating surface thereof.

If the boiler feed water contains also hard-scale-forming matter, that is, so-called "permanent" hardness, consisting of sulphates, nitrates, etc., the functions of the Cochrane Heater are modified to provide for the automatic introduction of the right amount of reagent for the correction of this condition.

We guarantee that where boilers are fed with water softened by the SORGE-COCHRANE HOT PROCESS SYSTEM, installed and operated in accordance with our instructions, hard scale will not form in the boilers, nor will they be subject to corrosion.

The Cochrane Heater serves as a hot well for all water about the plant suitable for boiler feeding purposes, such as live steam drips, returns from heating systems, calendering rolls, etc.

The Cochrane Heater performs the function of automatic makeup water regulator, admitting just the amount of cold raw water required to supplement the condensed returns.

If heat is required for heating or drying purposes about the plant, a Cochrane Steam-Stack and Cut-Out Valve Heater and Receiver should be installed, which, in addition to the functions mentioned above, also takes the place of an independent oil separator installed in a by-pass around an ordinary heater and receiver, thus saving the cost of the independent separator and of the trap, valves, fittings and piping required for its installation.

The Cochrane Open Feed Water Heater has occupied the pinnacle of excellence ever since its introduction over twenty years ago. Our experience in installing some 8,000,000 H. P. capacity of Cochrane Feed Water Heaters has taught us many things regarding the heating and softening of water for boiler feeding and other purposes, and regarding the removal of oil and water from steam that may enable us to save money for you in your plant. If you would like to use exhaust steam for heating or drying purposes, or in an exhaust turbine, are troubled with water in your engine, have difficulty in securing proper cylinder lubrication, find that your boilers need cleaning or repairing too frequently, are compelled to reduce your boiler pressure because of corrosion, or need more boiler capacity, send us particulars, and we shall be pleased to give you the benefit of our suggestions, and to prepare the layout of a suitable arrangement for improving your plant.

Engineering Department,

Harrison Safety Boiler Works

17th and Clearfield Streets **Philadelphia, Pa.**

CLASSIFIED INDEX *to* ARTICLES ADVERTISED

Air Compressors
Bates Machine Co.....101
Fairbanks, Morse & Co.....110
Ingersoll-Rand Co.....118
Laidlaw-Dunn-Gordon Co..... 77
Union Steam Pump Co..... 98

Alarms, Low Water
Lunkenheimer Co..... 4
Reliance Gauge Column Co... 94
Wright Mfg. Co..... 94

Alternators
Allis-Chalmers Co..... 98
General Electric Co.....117

Asbestos Goods and Materials
Johns-Manville Co., H. W.... 74

Belt Dressing
Cling-Surface Co..... 97
Garlock Packing Co..... 9
Keystone Lubricating Co..... 3
Schieren Co., Chas. A..... 96
Smooth-On Mfg. Co..... 6
Walton Co., F. S.....16 and 17

Belt Fasteners
Bristol Co.....4th cover

Belt Lace
Schieren Co., Chas. A..... 96

Belting
Diamond Rubber Co..... 84
Garlock Packing Co..... 9
New York Belting & Pack. Co. 10
Peerless Rubber Mfg. Co..... 8
Rhodes & Sons, J. E....1st cover
Schieren Co., Chas. A..... 96

Belting, Chain
Morse Chain Co..... 96

Blocks, Chain
Yale & Towne Mfg. Co..... 88

Blowers, Fan
Green Fuel Economizer Co... 79
Ohio Blower Co..... 93
Sturtevant Co., B. F.....109
Turbo-Blower Co..... 77
Wing Mfg. Co., L. J..... 79

Blowers, Steam Jet
McClave-Brooks Co..... 12
Parson Mfg. Co..... 77

Boiler Compound
Dearborn Drug & Chemical Works 5
Johns-Manville Co., H. W.... 74
Keystone Lubricating Co..... 3
Liberty Mfg. Co..... 7

Boiler Fronts
Casey-Hedges Co.....105
Treadwell Co., M. H..... 78

Boiler Setting
Harbison-Walker Refractories Co. 107
McLeod & Henry Co.....106

Boiler Support
Lisk, J. P.....103

Boiler Tube Cap Reseating Machine
Lagonda Mfg. Co.....3d cover
Elliott Co. 7

Boilers
Babcock & Wilcox Co.....105
Casey-Hedges Co.....105
Fairbanks, Morse & Co.....110
Griffith & Wedge Co.....115
Griscom-Spencer Co..... 90
Harrisburg Foundry & Mach. Works 114
Harrison Safety Boiler Wks.. 65
Hawkes Boiler Co.....104
Heine Safety Boiler Co.....104
Hewes & Phillips Iron Wks...114
Houston, Stanwood & Gamble Co. 109
Keeler Co., E.....105
Kennicott Co., The.....103
Kingsford Fdry. & Mach. Co.. 104
Morrin Climax Boiler Co.....105
New Bedford Valve Mfg. Co.. 86
Oil Well Supply Co.....105
Robb-Mumford Boiler Co.....104
Struthers-Wells Co.....111
Vogt Machine Co., Henry....104
Wickes Boiler Co.....104
York Mfg. Co.....114

Books
International Textbook Co... 71
McGraw-Hill Book Co..... 72

Brick, Fire
Harbison-Walker Refractories Co. 107
McLeod & Henry Co.....106

Calorimeters
Sargent Steam Meter Co..... 109
Schaeffer & Budenberg Mfg. Co. .....4th cover

Castings, Brass and Iron
Bruce-Macbeth Eng. Co.....111
Builders Iron Foundry.....106
Hooven, Owens, Rentschler Co.115
Lunkenheimer Co., The..... 4
McClave-Brooks Co..... 12
Neemes Bros..... 78
Ohio Brass Co.....102
Salamander Grate Bar Co.... 78
Treadwell Co., M. H..... 78

Castings, Steel
Hooven, Owens, Rentschler Co.115
Treadwell Co., M. H..... 78

Cement, Iron
Johns-Manville Co., H. W.... 74
Smooth-On Mfg. Co..... 6

Cement, Rubber
Peerless Rubber Mfg. Co..... 8

Chain Drives
Morse Chain Co..... 96

Chimneys, Brick
Kellogg Co., M. W..... 87

Chimneys, Steel
Keeler Co., E.....105
Morrin Climax Boiler Co.....105
Treadwell Co., M. H..... 78

Clocks
American Steam Gauge and Valve Mfg. Co.....62 and 63

Clutches, Friction
Fairbanks, Morse & Co.....110
Williams Fdry. & Mach. Co.. 96

Cocks, Blow-off
Elliott Co..... 7
Hancock Inspirator Co..... 91

Cocks, Gage
American Steam Gauge and Valve Mfg. Co.....62 and 63
Huyette Co., Paul B.....103
Jenkins Bros..... 67
Lunkenheimer Co..... 4
Ohio Blower Co..... 93
Ohio Brass Co.....102
Reliance Gauge Column Co... 94
Wright Mfg. Co..... 94

Cocks, Steam
Dart Mfg. Co., E. M..... 87
Lunkenheimer Co..... 4
Schutte & Koerting Co..... 77

Combustion Chamber, Back Arch
Harbison-Walker Refractories Co. 107
McLeod & Henry Co.....106

Combustion Recorders
Precision Instrument Co..... 90
Uehling Instrument Co.....103

Commutator Compound
Acheson Graphite Co., International 80
Dixon Crucible Co., Jos..... 81

Condensers
Alberger Condenser Co..... 99
Anderson Co., V. D..... 94
Baragwanath & Son, Wm....100
Blake & Knowles Steam Pump Works 100
Cameron Steam Pump Works, A. S..... 98
Epping-Carpenter Co..... 98
Fairbanks, Morse & Co.....110
Griscom-Spencer Co..... 90
Kellogg Co., M. W..... 87
Schutte & Koerting Co..... 77
Union Steam Pump Co..... 98
Wheeler Mfg. Co., C. H..... 99

Controllers, Electric
General Electric Co.....117

Controllers, Feed Water
Mason Regulator Co..... 88
Northern Equipment Co.....103
Squires Co., C. E..... 96
Ziermore Regulator Co.....106

Cooling Plants
Schutte & Koerting Co..... 77

Cooling Towers
Wheeler Mfg. Co., C. H..... 99

Cordage
American Mfg. Co..... 97
Columbian Rope Co..... 96

Couplings, Flexible Shaft
Bruce-Macbeth Engine Co.....111
Hooven, Owens, Rentschler Co.115

Covering, Pipe and Boiler
Johns-Manville Co., H. W.... 74

Cranes
Yale & Towne Mfg. Co.....109

Crank Pin Oiler
Richardson-Phenix Co..... 81

Die Stocks
Bignall & Keeler Mfg. Co.... 87
Curtis & Curtis Co..... 87

Draft Apparatus, Mechanical
Engineer Co., The..... 90
Green Fuel Economizer Co... 79
Parson Mfg. Co..... 77
Schutte & Koerting Co..... 77
Sturtevant Co., B. F.....109
Turbo-Blower Co..... 77
Wing Mfg. Co., L. J..... 79

Drills, Upright
Barnes Co., W. F. & John....103

Dust Collectors
Ohio Blower Co..... 93

Dynamos
American Engine Co.....112
Bruce-Macbeth Eng. Co.....111
Fairbanks, Morse Co.....110
Fort Wayne Electric Works.. 83
General Electric Co..97 and 117
Ridgway Dynamo and Engine Co. 112
Westinghouse Machine Co....112

Economizers, Fuel
Green Fuel Economizer Co... 79
Parson Mfg. Co..... 77
Westinghouse Machine Co....112

Ejectors
Hayden & Derby Mfg. Co.... 91
Lunkenheimer Co..... 4
Manning, Maxwell & Moore.. 91
Penberthy Injector Co..... 13
Schutte & Koerting Co..... 77

Electric Current
New York Edison Co..... 76

Engine Stops
Schutte & Koerting Co..... 77

Engines, Combustion
Ajax Iron Works.....111
Allis-Chalmers Co..... 98
Bogart Gas Power Engine Co. 78
Bruce-Macbeth Eng. Co.....111
Buckeye Engine Co.....115
Du Bois Iron Works.....110
Elyria Gas Power Co.....111
Fairbanks, Morse & Co.....110
Foos Gas Engine Co.....111
Struthers-Wells Co.....111
Turner-Fricke Mfg. Co.....110
Westinghouse Machine Co....112

Engines, Steam
Allis-Chalmers Co..... 98
American Engine Co.....112
Ames Iron Works..... 74
Ball & Wood Co.....114
Ball Engine Co.....113
Bates Machine Co.....101
Brown Engine Co., C. H.....113
Brownell Co.....114
Buckeye Engine Co.....115
Cooper Co., C. & G.....114
Du Bois Iron Works.....110
Erie Mfg. & Supply Co.....112
Fairbanks, Morse & Co.....110
Fitchburg Steam Engine Co..113
Green Fuel Economizer Co... 79
Griffith & Wedge Co.....115
Griscom-Spencer Co..... 90
Harris Steam Engine Co..114
Harrisburg Fdry & Mach. Wks.114

Engines, Steam—*Continued.*
Hewes & Phillips Iron Wks..114
Hooven, Owens, Rentschler Co.115
Houston, Stanwood & Gamble Co. 109
McIntosh, Seymour & Co....116
Nagle Corliss Engine Wks....116
Providence Engr. Works.....115
Ridgway Dynamo & Engine Co.112
Rollins Engine Co.....114
Skinner Engine Co.....115
Sturtevant Co., B. F.....109
Watts-Campbell Co.....113
Westinghouse Machine Co....112
York Mfg. Co.....114

Exhaust Heads
Burt Mfg. Co..... 18
Hoppes Mfg. Co.....100
Ohio Blower Co..... 95
Patterson & Co., Frank L.... 74
Robertson & Sons, Jas. L.... 73
Sturtevant Co., B. F.....109
Whitlock Coil Pipe Co..... 76
Wright Mfg. Co..... 94

Expansion Joints
Alberger Condenser Co..... 99

Fans, Exhaust and Ventilating
Anderson Co., V. D..... 94
General Electric Co.....117
Green Fuel Economizer Co... 79
Power Specialty Co..... 85
Turbo-Blower Co..... 77
Wing Mfg. Co., L. J..... 79

Feed Water Weighers
Kennicott Co. 103
Willcox Engr. Co.....102

Feeders, Furnace
Ohio Blower Co..... 95

Files and Rasps
Nicholson File Co.....100

Filters, Oil
Burt Mfg. Co..... 18
Elliott Co..... 7
Richardson-Phenix Co..... 81
Robertson & Sons, Jas. L.... 73
Wright Mfg. Co..... 94

Fire Clay
Harbison-Walker Refractories Co. 107

Firebox Blocks
Harbison-Walker Refractories Co. 107
McLeod & Henry Co.....106

Fittings, Ammonia
American Steam Gauge and Valve Mfg. Co.....62 and 63
York Mfg. Co.....114

Flanges
Ball & Wood Co.....114
Dart Mfg. Co., E. M..... 87
Jefferson Union Co..... 14

Floats
Anderson Co., V. D..... 94
Schutte & Koerting Co..... 77

Flue Gas Analysis Instruments
Pierce Co., Wm. B.....2d cover

Furnace Door Arch
McLeod & Henry Co.....106

Furnaces, Smokeless
McClave-Brooks Co..... 12
Murphy Iron Works..... 78

Gage Boards
American Steam Gauge and Valve Mfg. Co.....62 and 63

Gage Glasses
American Steam Gauge and Valve Mfg. Co.....62 and 63
Ashcroft Mfg. Co..... 91
Chesterton Co., A. W.....103
Garlock Packing Co..... 9
Manning, Maxwell & Moore.. 91
Peerless Rubber Mfg. Co..... 8

Gage Testing Outfit
American Steam Gauge and Valve Mfg. Co.....62 and 63

Gages, Draft
American Steam Gauge and Valve Mfg. Co.....62 and 63
Bristol Co.....4th cover
Sargent Steam Meter Co.....109
Schaeffer & Budenberg Mfg. Co. .....4th cover

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Gages, Pressure

American Steam Gauge and Valve Mfg. Co.....62 and 63
Ashton Valve Co..... 86
Crosby Steam Gage & Valve Co. 88
Schaeffer & Budenberg Mfg. Co. .....4th cover

Gages, Recording

American Steam Gauge and Valve Mfg. Co.....62 and 63
Ashton Valve Co..... 86
Bristol Co.....4th cover
Schaeffer & Budenberg Mfg. Co. .....4th cover

Gages, Vacuum

American Steam Gauge and Valve Mfg. Co.....62 and 63
Schaeffer & Budenberg Mfg. Co. .....4th cover
Schutte & Koerting Co..... 77

Gages, Water

American Steam Gauge and Valve Mfg. Co.....62 and 63
Greene, Tweed & Co., 84 and 4th cover
Huyette Co., Paul B.....103
Jenkins Bros..... 67
Lunkenheimer Co..... 4
Ohio Blower Co..... 93
Ohio Brass Co.....102
Reliance Gauge Column Co... 94
Wright Mfg. Co..... 94

Gas Exhausters

Ohio Blower Co..... 93

Gas Producers

Du Bois Iron Works.....110
Foos Gas Engine Co.....111
Griscom-Spencer Co..... 90
Westinghouse Machine Co....112

Gaskets

Akron Metallic Gasket..... 85
American Goetze-Gasket and Packing Co..... 85
Cancos Mfg. Co..... 85
Diamond Rubber Co..... 84
Eureka Packing Co..... 69
Garlock Packing Co..... 9
Greene, Tweed & Co., 83 and 4th cover
Jenkins Bros..... 67
Johns-Manville Co., H. W.... 74
Keeler Co., E.....105
McCord Mfg. Co..... 75
National India Rubber Co.... 85
New York Belting & Packing Co. 10
Peerless Rubber Mfg. Co..... 8
Smooth-On Mfg. Co..... 6

Gears

New Process Raw Hide Co... 96

Governors, Pump

Foster Engineering Co..... 87
Mason Regulator Co..... 88
Northern Equipment Co.....103
Squires Co., C. E..... 96
Watson & McDaniel Co..... 98
Ziermore Regulator Co.....106

Governors, Pump Speed

Mason Regulator Co..... 88
Ziermore Regulator Co.....106

Graphite

Acheson Graphite Co., International 80
Dixon Crucible Co., Jos..... 81
Garlock Packing Co..... 9

Grates

Casey-Hedges Co.....105
McClave-Brooks Co..... 12
Martin Grate Co..... 78
Neemes Bros..... 78
Perfection Grate Co..... 78
Robertson & Sons, Jas. L.... 73
Salamander Grate Bar Co.... 78
Treadwell Co., M. H..... 78
Washburn-Granger Co..... 78

Grease

Acheson Graphite Co., International 80
Albany Lubricating Co..... 82
Cataract Refining & Mfg. Co.. 80
Dearborn Drug & Chemical Works 5
Dixon Crucible Co., Jos..... 81
Kellogg & Co., E. H..... 74
Keystone Lubricating Co..... 3
N. Y. & N. J. Lub. Co..... 83
Philadelphia Grease Co..... 80
Universal Lubricating Co.... 15
Walton Co., F. S.....16 and 17

Grease Extractors

Griscom-Spencer Co..... 90

Heaters and Purifiers, Feed Water

Alberger Condenser Co..... 99
Baragwanath & Son, Wm.....100
Bates Machine Co.....101
Blake & Knowles Steam Pump Works..... 100
Casey-Hedges Co.....105
Erie Mfg. & Supply Co.....112
Green Fuel Economizer Co... 79
Griscom-Spencer Co..... 90
Harrison Safety Boiler Wks.. 65
Hoppes Mfg. Co.....100
National Pipe Bending Co....101
Open Coil Heater & Purifier Co. 101
Patterson & Co., Frank L.... 74
Robertson & Sons, Jas. L.... 73
Wheeler Mfg. Co., C. H..... 99
Whitlock Coil Pipe Co.....102
Wickes Boiler Co.....104
Williams Tool Co.....101

Heating and Ventilating Systems

Green Fuel Economizer Co.... 79
Ohio Blower Co..... 93
Schutte & Koerting Co..... 77
Wing Mfg. Co., L. J..... 79

Heating, Central Station

American District Steam Co..102

Hoists, Electric

Allis-Chalmers Co..... 98
Yale & Towne Mfg. Co..... 88

Hoists, Gas Engine

Foos Gas Engine Co.....111

Hoists, Hand

Yale & Towne Mfg. Co..... 88

Hose, Metal

American Metal Hose Co..... 84

Hose, Rubber

Diamond Rubber Co..... 84
Garlock Packing Co..... 9
Lagonda Mfg. Co.....3d cover
New York Belting & Packing Co. 10
Peerless Rubber Mfg. Co..... 8
Pennsylvania Flexible Metallic Tubing Co..... 90

Ice and Refrigerating Machinery

Vogt Machine Co.....104
York Mfg. Co.....114

Indicators, Ammonia

American Steam Gauge and Valve Mfg. Co.....62 and 63

Indicators, Flow

Richardson-Phenix Co..... 81

Indicators, Gas Engine

American Steam Gauge and Valve Mfg. Co.....62 and 63
Ashcroft Mfg. Co..... 91
Manning, Maxwell & Moore... 91
Schaeffer & Budenberg Mfg. Co. .....4th cover

Indicators, Speed

Schaeffer & Budenberg Mfg. Co. .....4th cover
Starrett Co., L. S.....108

Indicators, Steam Engine

American Steam Gauge and Valve Mfg. Co.....62 and 63
Ashcroft Mfg. Co..... 91
Crosby Steam Gage & Valve Co. 88
Manning, Maxwell & Moore... 91
Robertson & Sons, Jas. L.... 73
Schaeffer & Budenberg Mfg. Co. .....4th cover

Injectors

Hayden & Derby Mfg. Co.... 91
Jenkins Bros..... 67
Lunkenheimer Co..... 4
Manning, Maxwell & Moore... 91
Penberthy Injector Co..... 14
Robertson & Sons, Jas. L.... 73
Schutte & Koerting Co..... 77

Lamps, Acetylene

Simmons Co., John..... 81

Lamps, Electric

General Electric Co.....117
Johns-Manville Co., H. W.... 74
Westinghouse Machine Co....112

Lathes, Foot Power

Barnes Co., W. F. & John....103

Lubricators, Cylinder

Albany Lubricating Co..... 82
Detroit Lubricator Co..... 81
Greene, Tweed & Co., 84 and 4th cover
Griscom-Spencer Co..... 90
Lunkenheimer Co..... 4

Lubricators, Cylinder—*Cont.*

Manzel Bros. Co..... 80
Richardson-Phenix Co..... 81
Robertson & Sons, Jas. L.... 73
Universal Lubricator Co..... 15

Lubricators, Force Feed

Lunkenheimer Co..... 4
McCord Mfg. Co..... 75
Richardson-Phenix Co..... 81

Mats and Matting

Diamond Rubber Co..... 84
New York Belting & Packing Co 10
Peerless Rubber Mfg. Co.... 8

Metal, Bearing

Allan & Son, A.....114
Leddell-Bigelow Co.....110
Magnolia Metal Co.....111

Meters, Water

Builders Iron Foundry.....106
Sargent Steam Meter Co.....109

Micrometers

Starrett Co., L. S.....108

Milling Machines, Portable

Underwood & Co., H. B.....114

Motors, Electric

Allis-Chalmers Co..... 98
American Engine Co.....116
Fairbanks, Morse & Co.....110
Fort Wayne Electric Wks.... 83
General Electric Co.....117
Ridgway Dynamo & Engine Co 112
Sturtevant Co., B. F.....109

Motors, Water

Lagonda Mfg. Co.....3d cover

Oil and Grease Cups

Albany Lubricating Co..... 82
Detroit Lubricating Co..... 81
Elliott Co..... 7
Keystone Lubricating Co.... 3
Lunkenheimer Co..... 4
N. Y. & N. J. Lubricant Co... 83
Richardson-Phenix Co..... 81
Schaeffer & Budenberg Mfg. Co. .....4th cover
Universal Lubricator Co..... 15

Oil Burners

Hammel Oil Burner Co..... 77
Lunkenheimer Co..... 4
Parson Mfg. Co..... 73

Oil Reservoirs

Burt Mfg. Co..... 18
Richardson-Phenix Co..... 81

Oiling Systems

Albany Lubricating Co..... 82
Burt Mfg. Co..... 18
Detroit Lubricator Co..... 81
Lunkenheimer Co..... 4
Richardson-Phenix Co..... 81

Oils

Albany Lubricating Co..... 82
Dearborn Drug & Chemical Works 5
Kellogg & Co., E. H..... 74
N. Y. & N. J. Lubricant Co... 83
Standard Oil Co..... 82
Walton Co., F. S.....16 and 17

Packing, Flange

American Goetze-Gasket & Packing Co..... 85
Cancos Mfg. Co..... 85
Chesterton Co., A. W.....103
Diamond Rubber Co..... 84
Eureka Packing Co..... 69
Garlock Packing Co..... 9
Greene, Tweed & Co., 84 and 4th cover
Jenkins Bros..... 67
Johns-Manville Co., H. W.... 74
McCord Mfg. Co..... 75
National India Rubber Co... 85
New York Belting & Packing Co. 10
Peerless Rubber Mfg. Co.... 8
Rhoads & Sons, J. E...1st cover
Smooth-On Mfg. Co..... 6
Thermoid Rubber Co..... 11
Von Kokeritz & Co., R. G.... 84

Packing, Hydraulic

Cancos Mfg. Co..... 85
Chesterton Co., A. W.....103
Diamond Rubber Co..... 84
Garlock Packing Co..... 89
Johns-Manville Co., H. W.... 74
Robertson & Sons, Jas. L.... 73
Schieren Co., Chas. A..... 96
Steel Mill Packing Co..... 85
Tripp Metallic Packing Co... 85
Von Kokeritz & Co., R. G.... 84

Packing, Piston Rod

American Goetze-Gasket and Packing Co..... 85
Cancos Mfg. Co..... 85

Packing, Piston Rod—*Cont.*

Chesterton Co., A. W.....103
Diamond Rubber Co..... 84
Eureka Packing Co..... '9
Garlock Packing Co..... 9
Greene, Tweed & Co., 84 and 4th cover
National India Rubber Co.... 85
New York Belting and Packing Co..... 10
Nugget Packing Co..... 84
Peerless Rubber Mfg. Co..... 8
Power Specialty Co..... 85
Steel Mill Packing Co..... 85
Thermoid Rubber Co..... 11
Tripp Metallic Packing Co... 85
Von Kokeritz & Co., R. G.... 84

Packing, Pump Valve

Cancos Mfg. Co..... 85
Diamond Rubber Co..... 84
Von Kokeritz & Co., R. G.... 84

Packing, Valve Stem

Cancos Mfg. Co..... 85
Diamond Rubber Co..... 84
Greene, Tweed & Co., 84 and 4th cover
Tripp Metallic Packing Co... 85

Pipe

Ball & Wood Co.....114
Kellogg Co., M. W..... 87
National Tube Co..... 81

Pipe Bending

Ball & Wood Co.....114
Kellogg Co., M. W..... 87
National Pipe Bending Co.... 81
Whitlock Coil Pipe Co..... 76

Pipe Clamp

Simplex Engineering Co..... 87

Pipe Coils

National Pipe Bending Co.... 81
Whitlock Coil Pipe Co..... 76

Pipe Cutting and Threading Machines

Armstrong Mfg. Co..... 81
Bignall & Keeler Mfg. Co.... 87
Curtis & Curtis Co..... 87
Toledo Pipe Threading Mach. Co. 86
Treadwell Co., M. H..... 78
Trimont Mfg. Co.....108

Pipe, Riveted Steel

Kennicott Co., The.....103

Piping, Blow

Ohio Blower Co..... 93

Piping, High Pressure

Kellogg Co., M. W..... 87

Planimeters

American Steam Gauge and Valve Mfg. Co.....62 and 63
Ashcroft Mfg. Co..... 91
Manning, Maxwell & Moore... 91
Robertson & Sons, Jas. L.... 73

Plumbago

Acheson Graphite Co., International 80
Dixon Crucible Co., Jos..... 81

Polish, Metal

Hoffman, Geo. W..... 77
Johns-Manville Co., H. W.... 74

Publishers

International Textbook Co.... 71
McGraw-Hill Book Co..... 72

Pulleys

Saginaw Mfg. Co..... 96

Pumps, Air

Blake & Knowles Steam Pump Works 100
Cameron Steam Pump Wks., A. S. 98
Deming Co..... 99
Du Bois Iron Works.....110
Wheeler Mfg. Co., C. H..... 99
Wilson, C. E..... 99

Pumps, Centrifugal

Alberger Condenser Co..... 99
Allis-Chalmers Co..... 98
De Laval Steam Turbine Co.. 98
Deming Co..... 99
Wilson, C. E..... 99
Worthington, Henry R..... 99

Pumps, Deep Well

Cameron Steam Pump Wks., A. S..... 98
Wilson, C. E..... 99

Pumps, Electric

De Laval Steam Turbine Co.. 98
Du Bois Iron Works.....110
Goulds Mfg. Co..... 98
Westinghouse Machine Co....112
Wilson, C. E..... 99

The "Eureka" Square Deal

Published every other week in the interests of honesty in the packing business.

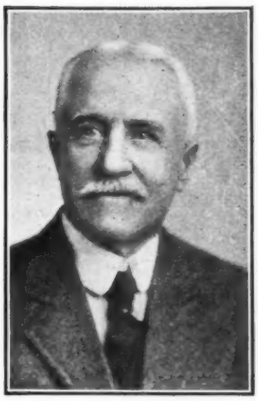
Vol. I. **By James L. Robertson.** No. I

"Graft" Has Worked Into The Packing Business

I shall have a few things to say in this space every other week about the "square deal" in the packing business.

As a general proposition I don't believe in exploiting my picture.

What I look like is no good reason why you should or should not buy **Eureka Packing.**



JAMES L. ROBERTSON

But this series of talks is to be a man-to-man series and I want you to know whom you're dealing with. For a great many years **Eureka Packing** has been sold all over the world without the aid of salesmen outside the New York City district.

During all these years it has been sold strictly through dealers and "on the level."

Now, a new condition confronts me and every other "square deal" manufacturer of packing. That condition is the "graft" beast which has reared its head high enough to be noticeable.

The gentleman with a near-good packing and the balance-in-cash-for-the-buyer is on the job.

He insiduously argues that a near-good packing accompanied by a cash bonus for the buyer is better for the buyer than an all-good packing. Those are not his *words*, but the bait he throws out.

In plain language he is offering graft and some people are falling for it.

This condition cannot last for long—there's a time of reckoning for every giver and taker of a bribe.

But the condition will last long enough to damage the honest manufacturer and the honest buyer who will suffer for the misdeeds of the dishonest minority, unless self-respecting engineers correct it.

So, I'm coming out squarely and fairly, without mincing words, and putting it up to the square and fair majority of engineers to buy all their packing from only honest makers.

I hope, of course, that they will buy "Eureka" but, more than all, that they will signify their belief in the "square deal" by buying *some* packing which carries nothing with it but its merits as a packing.

For 30 years I have asked engineers for business on this basis and have never asked in vain. Nor shall I appeal in vain this time. The *square* engineer is the big influence in a profession than which there is none more honorable. I should like to have *your* opinion on this whole subject.

Eureka Packing—39 Varieties—Have You A Catalog?

Eureka Packing Co., (Jas. L. Robertson, President.) 76-78 Murray St., New York

Pumps, Oil

Blake & Knowles Steam Pump Works.....100
Burt Mfg. Co.....18
Cameron Steam Pump Wks., A. S.....98
Du Bois Iron Works.....110
Goulds Mfg. Co.....98
Lunkenheimer Co.....4
Manzel Bros. Co.....80
Richardson-Phenix Co.....81
Wilson, C. E.....99

Pumps, Oil Force-feed

Detroit Lubricator Co.....81
Lunkenheimer Co.....4
Richardson-Phenix Co.....81

Pumps, Power

Blake & Knowles Steam Pump Works.....100
Deming Co.....99
Du Bois Iron Works.....110
Goulds Mfg. Co.....98
Patterson & Co., Frank L....74
Union Steam Pump Co.....98
Whitlock Coil Pipe Co.....76
Wilson, C. E.....99

Pumps, Steam

Blake & Knowles Steam Pump Works.....100
Cameron Steam Pump Wks., A. S.....98
De Laval Steam Turbine Co..98
Deming Co.....99
Du Bois Iron Works.....110
Eoping-Carpenter Co.....98
Jamieson & Co., M. W.....74
Union Steam Pump Co.....98
Wheeler Mfg. Co., C. H.....99
Wilson, C. E.....99
Worthington, Henry R.....99

Pumps, Turbine

De Laval Steam Turbine Co..98

Pumps, Vacuum

Alberger Condenser Co.....99
Blake & Knowles Steam Pump Works.....100
Cameron Steam Pump Wks., A. S.....98
Union Steam Pump Co.....98
Wheeler Mfg. Co., C. H.....99
Wilson, C. E.....99

Pyrometers

American Steam Gauge and Valve Mfg. Co.....62 and 63
Schaeffer & Budenberg Mfg. Co. .....4th cover
Uehling Instrument Co.....103

Rams, Steam

Penberthy Injector Co.....13

Reducing Wheels

American Steam Gauge and Valve Mfg. Co.....62 and 63
Robertson & Sons, Jas. L....73

Regulators, Damper

Lagonda Mfg. Co.....3d cover
Mason Regulator Co.....89
Robertson & Sons, Jas. L....73

Regulators, Feed Water

Elliott Co.....7
Lagonda Mfg. Co.....3d cover
Northern Equipment Co.....103
Squires Co., C. E.....96
Ziermore Regulator Co.....106

Regulators, Pressure

Foster Engineering Co.....87
Lagonda Mfg. Co.....3d cover
Mason Regulator Co.....88
Northern Equipment Co.....103
Ohio Brass Co.....102
Squires Co., C. E.....96
Steam Appliance Co.....94
Ziermore Regulator Co.....106

Regulators, Pump

Hughson Steam Specialty Co. 88
Mason Regulator Co.....88
Squires Co., C. E.....96
Ziermore Regulator Co.....106

Repairs, Engine

Underwood & Co., H. B.....114

Revolution Counters

American Steam Gauge and Valve Mfg. Co.....62 and 63
Schaeffer & Budenberg Mfg. Co. .....4th cover
Schuchardt & Schutte.....108

Rope, Transmission

American Mfg. Co.....97
Columbian Rope Co.....96

Rubber Joints

Diamond Rubber Co.....84

Separators, Ammonia

Harrison Safety Boiler Wks..65

Separators, Oil

American Radiator Co.....92
Austin Separator Co.....94
Baragwanath & Son, Wm.....100
Elliott Co.....7
Harrison Safety Boiler Wks..65
Hoppes Mfg. Co.....100
Ohio Blower Co.....93
Robertson & Sons, Jas. L....73
Steam Appliance Co.....94
Wright Mfg. Co.....94

Separators, Steam

American Radiator Co.....92
Austin Separator Co.....94
Baragwanath & Son, Wm....100
Elliott Co.....7
Griscom-Spencer Co.....90
Harrison Safety Boiler Wks..65
Hoppes Mfg. Co.....100
Ohio Blower Co.....93
Patterson & Co., Frank L....74
Robertson & Sons, Jas. L....73
Steam Appliance Co.....94
Whitlock Coil Pipe Co.....76
Wright Mfg. Co.....94

Skylights

Burt Mfg. Co.....18

Stokers, Mechanical

American Ship Windlass Co..79
Babcock & Wilcox Co.....105
McClave-Brooks Co.....12
Murphy Iron Works.....78
Parson Mfg. Co.....77
Under-Feed Stoker Company of America 79
Westinghouse Machine Co....112

Strainers, Water

Elliott Co.....7
Hayden & Derby Mfg. Co.....91

Superheaters

Babcock & Wilcox Co.....105
Lagonda Mfg. Co.....3d cover
Power Specialty Co.....85
Providence Engineering Wks.115

Switchboards

General Electric Co.....117
Westinghouse Machine Co....112

Tachometers

Schaeffer & Budenberg Mfg. Co. .....4th cover
Schuchardt & Schutte.....108

Tanks

Griscom-Spencer Co.....90
Kennicott Co., The.....103

Taps, Stocks and Dies

Armstrong Mfg. Co.....87
Bignall & Keeler Mfg. Co....87
Curtis & Curtis Co.....87
Toledo Pipe Threading Machine Co.....86

Thermometers

Bristol Co.....4th cover
Schaeffer & Budenberg Mfg. Co.....4th cover

Transformers and Converters

General Electric Co.....117
Westinghouse Machine Co....112

Transmission, Power

American Mfg. Co.....97
Columbian Rope Co.....96
Morse Chain Co.....96
Rhoads & Sons, J. E...1st cover
Saginaw Mfg. Co.....96

Traps, Steam

American Radiator Co.....92
Anderson Co., V. D.....94
Griscom-Spencer Co.....90
Jenkins Bros. 67
Morehead Mfg. Co.....92
Newhall Engr. Co., Geo. M...95
Ohio Blower Co.....93
Open Coil Heater & Purifier Co 101
Reliance Gauge Column Co....94
Schutte & Koerting Co.....77
Squires Co., C. E.....96
Steam Appliance Co.....94
Watson & McDaniel Co.....98
Wright Mfg. Co.....94

Traps, Vacuum

American Radiator Co.....92
Griscom-Spencer Co.....90
Morehead Mfg. Co.....92
Open Coil Heater & Purifier Co. 101

Tube Cleaners

Chesterton Co., A. W.....103
Garlock Packing Co.....9
Johns-Manville Co., H. W....74
Lagonda Mfg. Co.....3d cover
Liberty Mfg. Co.....7
Pierce Co., Wm. B.....2d cover
Robertson & Sons, Jas. L....73
Steam Appliance Co.....94

Tube Cutters

Lagonda Mfg. Co.....3d cover

Tubing

Johns-Manville Co., H. W....74
National Tube Co.....81

Tubing, Metallic

Pennsylvania Flexible Metallic Tubing Co.....90

Turbines, Hydraulic

Allis-Chalmers Co.....98

Turbines, Steam

Allis-Chalmers Co.....98
De Laval Steam Turbine Co..98
General Electric Co.....117
Hooven, Owens, Rentschler Co.115
Kerr Turbine Co.....113
Westinghouse Machine Co....112

Unions

Dart Mfg. Co., E. M.....87
Jefferson Union Co.....14
Lunkenheimer Co.....4
National Tube Co.....81
Ohio Brass Co.....102

Valve Balls

Diamond Rubber Co.....84

Valve Disks

Allan & Son, A.....114
American Goetze-Gasket and Packing Co.....85
Diamond Rubber Co.....84

Valve Washers, Leather

Rhoads & Sons, J. E...1st cover
Schieren Co., Chas. A.....96

Valves, Ammonia

Chapman Valve Mfg. Co.....85
Monarch Valve & Mfg. Co....88
York Mfg. Co.....114

Valves, Angle

Homestead Valve Mfg. Co....86
Lunkenheimer Co.....4
Monarch Valve & Mfg. Co....88
New Bedford Valve Mfg. Co..86
Ohio Brass Co.....102

Valves, Back Pressure

Foster Engineering Co.....87
Hughson Steam Specialty Co. 88
Jenkins Bros.....67

Valves, Blow-off

Elliott Co.....7
Hancock Inspirator Co.....91
Homestead Valve Mfg. Co....86
Jenkins Bros.....67
Lunkenheimer Co.....4
Powell Co., Wm.....86
Simplex Engineering Co.....81
Ziermore Regulator Co.....106

Valves, By-Pass

Nelson Valve Co.....89

Valves, Check

Greene, Tweed & Co., 84 and 4th cover
Jenkins Bros.....67
Lunkenheimer Co.....4
Nelson Valve Co.....89
National Tube Co.....81
Ohio Brass Co.....102

Valves, Cylinder Relief

American Steam Gauge and Valve Mfg. Co.....62 and 63
Consolidated Safety Valve Co. 91
Lunkenheimer Co.....4

Valves, Exhaust Relief

Alberger Condenser Co.....99
Jenkins Bros.....67

Valves, Free Exhaust

Schutte & Koerting Co.....77

Valves, Gate

Chapman Valve Mfg. Co.....85
Detroit Lubricator Co.....81
Greene, Tweed & Co., 84 and 4th cover
Jenkins Bros.....67
Lunkenheimer Co.....4
National Tube Co.....81
Nelson Valve Co.....81
Pittsburgh Valve, Fdry. & Construction Co.....87
Powell Co., Wm.....86

Valves, Globe

Detroit Lubricator Co.....81
Jenkins Bros.....67
Lunkenheimer Co.....4
National Tube Co.....81
Nelson Valve Co.....67
New Bedford Valve Mfg. Co..86
Ohio Brass Co.....102
Pittsburgh Valve, Fdry. and Construction Co.....87
Powell Co., Wm.....86

Valves, Piston

Baker Valve Co.....109

Valves, Pump

Garlock Packing Co.....9
Jenkins Bros.....67
New York Belting & Packing Co. 10
Peerless Rubber Mfg. Co.....8

Valves, Regrinding

Lunkenheimer Co.....4
Nelson Valve Co.....67

Valves, Return Stop

Foster Engineering Co.....87
Lagonda Mfg. Co.....3d cover

Valves, Safety

American Steam Gauge and Valve Mfg. Co.....62 and 63
Ashton Valve Co.....86
Crosby Steam Gage & Valve Co. 88
Detroit Lubricator Co.....81
Jenkins Bros.....67
Lunkenheimer Co.....4
Pittsburgh Valve, Fdry. and Construction Co.....87
Powell Co., Wm.....86

Valves, Tank

Nelson Valve Co.....67

Valves, Throttle

Detroit Lubricator Co.....81

Valves, Trip Throttle

Schutte & Koerting Co.....77

Ventilators

Burt Mfg. Co.....18
Ohio Blower Co.....93
Schutte & Koerting Co.....77
Turbo-Blower Co.....77
Wing Mfg. Co., L. J.....79

Vises

Armstrong Mfg. Co.....87

Water Columns

American Steam Gauge and Valve Mfg. Co.....62 and 63
Huyette Co., P. B.....103
Lunkenheimer Co.....4
Ohio Brass Co.....102
Reliance Gauge Column Co...94
Robertson & Sons, Jas. L....73
Wright Mfg. Co.....94

Water Softening Apparatus

Dearborn Drug & Chemical Works 5
Harrison Safety Boiler Wks..65
Kennicott Co., The.....103
Scaife & Sons Co., Wm.....77

Water Weighers

Willcox Engineering Co.....102

Whistles

American Steam Gauge and Valve Mfg. Co.....62 and 63
Lunkenheimer Co.....4

Wrenches, Nut and Bolt

Trimont Mfg. Co.....108

Wrenches, Pipe

Trimont Mfg. Co.....108
Williams & Co., J. H.....108